Paving and Municipal Engineering

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THEORETICAL PROPERTIES OF ASPHALTS.

THE competitions of business in asphalt paving has led to declarations, both direct and indirect, concerning the physical properties of asphalts which do not, in many cases, bear close scrutiny. For instance, referring to an article in the November number of this magazine, we may there read a long series of definitely and emphatically stated opinions, all set forth as what either *must* or *must not* be in an asphalt suitable for paving uses. The word *must* is uncompromising in sense, and, as used by the writer, justifies forming a conclusion that either he does not command the English language, or that these opinions are without reason for existence. The asphalt paving industry is one of great importance; and experience rather than theory has so far guided its development. There is a wide difference of opinion as to the why and wherefore of changes in the physical properties of asphalts under treatment, between the men who use it, and the men who evolve from their inner consciousness opinions of what takes place. False opinions, if accepted, have not only to be unlearned, but to be overcome, with more or less detriment to the related interests. Chemical research is yet to discover and definitely declare upon what chemical conditions the physical properties of asphalts depend, and in what way they are to be modified to effect such physical changes as experience teaches will be beneficial. It took only ordinary powers of observation to see that oils softened asphalts, and that boiling hardened them; also that the dirt settled out of them when melted to a certain degree of fluidity. Beyond these simple operations there has accumulated in the minds of skillful mixers of cement, and layers of pavements, empirical knowledge of several detail operations which

constitute the wisdom of the business, and to which the men in the laboratory have made no notable contributions.

We are told in the article referred to, that after an asphalt, in its natural state, has been refined at 400° F.—(1), it must be compressible at 60° F.; (2), it must be viscous and malleable at 75° F.; (3), it must flow at 100° F.; and (4), it must have a fire test of at least 300° F.

Just what these declarations mean is not clear, for in all comparisons of the physical properties of materials, in whatever department of research, three things must be known before investigation can proceed. We must have a standard period of time or duration of test, and a standard of weight or pressure, to know that there has been an equality of stress in all cases; and knowing these, we then determine the temperature of effective result. Providing all these data, we will find in a case like this of refined asphalt, that the observations are without any direct value, as refined asphalt is never used in laying pavement. Only paving cement is used, in the making of which tempering oils are used which enter into solution with the asphalt, and give us something not closely comparable to the asphalt by itself. The maker of cement in any case varies his combination until the desired result is secured. As to (4), the length of time taken in boiling controls the fire test. If an asphalt contains too much of its oil-component, the remedy is to transform or remove it. If the carbo-component is too great we can add maltha to the asphalt to correct the ratio.

We are told that (5) it must not contain deleterious matter soluble in water, such as soluble salts; and (6), it must not be soluble in caustic potash or soda; and (7), it must not be soluble in alcohol in excess of three per cent.; and (8), it must not yield less than 77 per cent. of petroline. Now, as stated, not one of these declarations is true. All asphalts yield results contradicting them. The gentlemen who announced these declarations has since published determinations of alcohol solubility as high as 20 per cent. of both Trinidad and Bermudez asphalts. If we applied his opinions to them, we should have to say they both were unsuitable for paving use.

We are told (9) that the manufactured pavement must not rot or disintegrate in contact with water, but the writer believes they all

will do so, and that all varieties of asphalt in general use have done so; and (10) that the asphalt must not contain over 20 per cent. of asphaltine; but many tried and approved pavements do contain more, and this without its percentage having been reduced by the use of maltha. Further we are told (11) the percentage of residuum oil required by the asphalt in the manufacture of cement must not be over 13 per cent. of the pure bitumen; but then the many million square yards of Trinidad asphalt pavements in use contradict this. For (12) we have it said that the asphalt must not contain a large percentage of organic matter not bitumen; what is a large percentage? Ninety per cent. would doubtless be very bad, while 10 per cent. may be a matter of indifference. Is it veiled wisdom which induces such statements? Recently a statement was published to the effect that some of the so-called organic matter not bitumen has been found to be only a less soluble form of the bitumen. If this is so, of what value are analyses affording data for condemning certain asphalts, after such inadequate work in examining them?

Opinionated chemists and speakers have declared that the so-called asphaltine was without cementitious properties. This is proven experimentally to be a mistake if intended to apply to the condition of this element in an asphalt cement. The writer dissolved some asphaltine in asphalt oil, and again in residuum oil, and in both cases found by tests that by mutual solution it joined in forming a cementitious body. In the process of making paving cements, it is believed, a like effect is secured. To this fact may be attributed the higher cohesive strength of some asphalts as compared with others containing less asphaltine. The cement mixer should be required to treat his charge of asphalt and oil until chemical union between the oil and asphalt is effected. Unless this result is secured the pavement is likely to be defective.

It is said that the viscous quality of the cement depends upon the presence of petroline. To the writer this declaration is open to objection. The components of an asphaltic cement are blended by solution so as to confer in their joint influence the cohesive strength of the combination, and one might with equal propriety say that the viscosity of a mucilage came from the liquid component and not from the gum.

In the language of Dr. T. Sterry Hunt, "solution is chemical

union;" "all chemical union is nothing else than solution; the uniting species are, as it were, dissolved in each other; for solution is mutual."

In a recent number of this magazine, in its advertising pages, the claim was bravely made that a particular asphalt was inferior to another for paving uses because of its lesser cohesive strength. Some years since the Inspector of Asphalts at Washington made a direct assertion that another certain asphalt was inferior because it was lacking (comparatively) in cementitious properties. It is unnecessary to extend references of this kind for they are all directly or deductively wrong. The writer long since concluded that if a street mixture has abundant strength to resist injurious deformation at the highest temperature to which exposed in any street where laid, its degree of strength was abundantly sufficient at all times; for as the temperature falls, the strength of an asphaltic cement rises rapidly, and it necessarily possesses surplus strength at all temperatures below the highest which it has withstood. It is amusing to see how quickly changed opinions were announced recently, when some tests were made showing how dangerous to certain vested interests were the opinions previously championed.

The writer determined in a single series of experiments, with half a dozen different paving cements, that the increase of cohesive strength, calculated for a square inch of area, from a strength of 100 pounds to 1,000 pounds of ultimate strength, was at rates varying between 30 pounds and 41 pounds for each degree centigrade, of fall in temperature. When able to repeat the tests, and secure further data, the general result will be published with graphic illustrations.

The lines obtained by platting these tests may yet prove of value in comparing cements. They are called "gradients of strength," or viscosity.

The writer has become possessed recently of a few formally stated comparisons of competing asphalts. In examining these reports it is found that certain asphalts are pronounced undesirable, because they contain too much oil—have too low softening and melting points; while, when the contest has changed, other asphalts are pronounced undesirable because containing less oil, the softening and melting points are too high. Now, the fact is, that in making

cements, these characteristics are regulated to suit the mixer. He uses cements only, not refined asphalts, and he brings his material to that particular standard of softness, etc., which he desires. All comparisons should, *in common honesty*, be made with cements. Possibly this would reform the expert business, if it would not kill it altogether.

Of what use can it be to determine the specific gravity of a refined asphalt? The presence of sand and other foreign materials in the samples may vary indefinitely, and so change the specific gravity of the mass, without affording the slightest indication of the quality of the soluble bitumen it may contain. The softening and melting points of a refined asphalt are of the slightest importance, as the mixer regulates them, and so with the experts, it is that they serve to fill out reports with more elaborate showing of useless information. The discussion of the color of a refined asphalt serves no valuable purpose. Recipients of reports containing elaborate discussions of color phenomena may not readily perceive that the only use actually made of them is to determine the source of an asphalt, not its fitness for use.

Attention is called to the mistake made by the author of the article in the November number of this magazine, wherein a "sulphuretted carburet of hydrogen" is called a chemically pure asphalt. One might as well call oxide of iron chemically pure iron, unless, of course, sulphur is considered as an elementary part of an asphalt. It may yet be learned that the state of solidification attained by a bitumen in becoming asphalt may be due to the presence of sulphur during the process; reference being made to those asphaltoids suitable for paving uses. There are processes for converting residuum oils into an artificial asphalt by combining sulphur with the oil after a special manner.

The determination of asphaltine as described in the original publication, by Boussingault (Annales de Chimie et de Phisique, 2d serie, vol. 64, p. 141, 1837), says: "After different essays, the means which I employed to free the bitumen from its volatile principle consist in its exposure to a temperature of about 250° [C.] in an oil stove of M. GayLussac, until it ceases to lose weight. This method is very long, the heating lasting from 45 to 50 hours, when operating with two grams of material."

In further illustration of the uncertainty of professional and expert opinion given to sustain vested interests, any one specially interested should read up the accounts of a legal contest had some forty years since in regard to the asphalt deposits of Nova Scotia. The mineral was called albertite. Certain valuable mining rights depended upon its being recognized as coal. So coal it was in the minds of many learned witnesses, and voluminous evidence and strongly expressed opinions were freely given to that effect, and they were all wrong.

The art of asphalt paving is yet in a comparatively crude state; the semblance of mystery which surrounds it is uncalled for, and prevents making improvements which are much to be desired. There are many workers in the business anxious to aid in its development, who have found that suggestions from them are not welcomed, and they learn to suppress new ideas, so as to avoid repulse. Consider this question: Ought pavements to be softer than now made in cold weather? can they be made so without being too soft in summer? and without lessening their durable service? Can the oxidation of asphalt be prevented in the pavements? The limestone dust added to the surface mixture effects both chemical and physical changes, and it would be valuable information to learn how these vary with changes in the proportions of dust used. It would be valuable to know also whether or not the solubility of the asphalt is different in the street mixture from what it is in the state of unused cement, for alcohol and the caustics, potash and soda. The general characteristics of asphalt are functions of the structure and arrangement of its molecules. Within these conditions it seems probable that the degree of fluidity is in some way dependent upon the hydrogen ratio. There is more hydrogen in petroleum than in maltha, and more in maltha than in solid asphalt. The components of an asphalt separated by successive solution in alcohol, ether and chloroform, contain in the order named lessening proportions of hydrogen. Dr. Kayser, with a sample of Trinidad asphalt of unknown variety, determined the successive solubilities to be: alcohol, 5 per cent.; ether, 57 per cent.; chloroform, 38 per cent. The centesimal proportions of carbon and hydrogen in these was respectively as follows:

	Alcohol.	Ether.	Chloroform.	Whole Sample.
Carbon,	.8889	.8903	.9014	.8934
Hydrogen,	.1111	.1097	.0986	.1066

These results show with how small a reduction in the proportion of hydrogen the character of the component groups in an asphalt are changed.

Without definitely committing himself to any theory of the structural nature of an asphalt, or as to the state of its component groups of hydrocarbons, the writer still has a working hypothesis to guide him in his investigations. It now assumes that an asphalt consists of *determined* hydrocarbons united into groups by polymeric condensation, which in the process of cooling of the material are successively solidified, until the last, in the order of the strength of their chemical affinities. It appears probable that the groups of these hydrocarbons are aggregated into larger molecules or *undetermined* alloys, which are separable by the action of solvents according to their special solving power. In this way is explained the different qualities of the material separated by alcohol, ether, chloroform, etc., from an asphalt under treatment. The long process of natural change which an asphalt undergoes from maltha to the coal-asphalts is called its ageing. The treatment it receives in refining and cement-making effects an ageing of the asphalt. It ages while lying in use in a pavement surface. The rapidity with which this last named process occurs may be spoken of as occurring inversely to its degree of chemical stability.

It is desirable to learn to what extent this ageing process may be a reversible reaction, and how we may renew or make younger an asphalt which is more aged than we desire to have it. Some of the changes which we observe to occur in asphalts are reversible. Actinic influence renders some components of an asphalt insoluble in solvents which readily dissolve it again after we melt it. It is not certain that there is any kind of asphalt which may not become by suitable treatment available for paving uses. What we have to learn is how to treat them. It is all wrong for any set of men to declare that the special treatment which they give their particular asphalts must be applied to all other kinds, and if when this is done, and the result is unsatisfactory, the asphalt must be condemned. We may well assume that such claims are intended to limit operations and

secure a special control of business. In expressing these views it is not forgotten that the cost of learning how to use an unproved asphalt may be far in excess of its commercial value.

To give a clearer conception of the writer's views of the nature of the changes which occur in the transformations of the hydrocarbons which are combined in an asphalt, the following extracts are given, from the writings of Dr. Henry Wurtz, of New York:

"The view that has now for many years been held by the writer, as to the main agencies of transformation of liquid rock oils into solid and semi-solid asphalts is based mainly on what is known as *polymerization*. This regarded by chemists in general as due to, and dependent on, the coalescence of two or more molecules of an element or compound into one, being inclusive and explanatory, as thus regarded, of allotropism of Berzelius.

"Not many years since almost the only instance of this sort of transformation on which stress was laid in the text-books of the schools, was the case of common acetic aldehyde. This transparent liquid, C H O, boiling at 70° F., never yet frozen, and having specific gravity .8—when simply put into contact with mere traces of sulphuric or hydrochloric or other acid at ordinary temperatures —spontaneously (the acid remaining entirely unaltered) becomes paraldehyde $C_6H_{12}O_3$, a liquid molecule made up of a congeries of three molecules of aldehyde itself, boiling now at 255° F., having the specific gravity of water, and freezing solid at 22° F. If the temperature of the aldehyde when in contact with the acid be below that of melting ice, a still more condensed and *solid* polymere, called metaldehyde, is formed. This, when quickly heated, may even be sublimed, and requires a temperature of 240° F., acting through many hours, to transform it back again into common aldehyde. Another aldehyde-polymere, aldol, is formed by simultaneous contact with an acid and water at low temperature. It is $C_4H_8O_2$, that is, *dialdehyde*, is syrupy or tar-like in consistence, and when once formed remains unaltered at the heat of boiling water."

"Other aldehydes undergo equally strange transmutions, and in the case of one of them, as will appear below, such transformations stand among the most wonderful and momentous yet developed by chemical science."

"It is to be remarked that in all cases of series of polymeres there is

a progressive increase in all chemical and physical properties as polymerism increases. Thus we have the three following polymeres:

Acetylene	C_2H_2, a permanent gas.					
Benzole	C_6H_6, a liquid;	specific	gravity,	.884;	boils,	177°
Stryolene	C_8H_8, a "	"	"	.926;	"	293°
Metastryolene	C_8H_8, a "	"	"	1.058.		

"We will now turn back to the aldehydes, and will find in a recent discovery of the illustrious German chemist, Baeyer (the discoverer of artificial indigo, sulphonal, etc., etc.), the wonderful series, hinted at above, of polymerisms, as produced by the rays of the sun. Baeyer finds that the primary function of the leaves of plants, under the sun's heat, is to form from carbonic dioxide and water the common *formic aldehyde*, CH_2O (discovered by Hoffman)."

"The chemical equation of this primary transformation is thus:

$$H_2O+CO_2=CH_2O+O_2;$$

free oxygen passing into the atmosphere, as we know is constantly the case, from the growing leaf. It will be seen that the other product besides the free oxygen, that is oxymethylene, may be looked upon as virtually a compound of carbon and water, H_2O. As it is a gaseous body, which is largely soluble in water, such a solution may be looked upon as in effect a solution of carbon in water. This body, oxymethylene, considered to be formic aldehyde, thus continually being formed in the plant leaf by a natural process, may be produced artificially by passing a mixture of vapor of wood alcohol and air over a red hot helix of copper or platinum wire contained in a glass tube. Such helix may be heated by an electric current.

Second.—Like other aldehydes (with many other organic bodies) this formic aldehyde has a fashion of forming *polymeres*, so called. In this case, just as with common or acetic aldehyde, three molecules combine together into one, thus:

$$3(CH_2O)=C_3H_6O_3.$$

This triplicated molecule constituting now a *solid* body instead of a gas. Such solidification of the gaseous compound takes place spontaneously in a concentrated watery solution. Now it happens (or rather results, for nothing can rightly be said to *happen* in chemical transformations, all being subject to fixed laws) that by carrying this polymerization twice as far as above, which the leaf

knows how to do, though we can not yet do it, there results $C_6H_{12}O_6$, which is *glucose*, or fruit sugar. Then by separating from this a molecule of water, H_2O, we get $C_6H_{10}O_5$, which is *starch*. By a second doubling up of glucose, and taking out a molecule of water, we get $C_{12}H_{22}O_{11}$, which is *cane sugar*. By taking out another molecule of water, we get $C_{12}H_{20}O_{10}$, which is *cellulose*, the main component of wood and of all plants. It may be observed that in all these cases the resulting polymere may still be regarded as a compound of carbon and water, and the energy that has come from the sun is locked up solely in the carbon atoms, which all come from the carbon dioxide gas of the air. There is no more beautiful development of chemical science than the one we have here been following up."

"The preceding discussion will, as the writer trusts, have rendered intelligible his view of the mode of formation of asphalts and asphaltoids from rock-oils, thus: Asphalts and asphaltoids are mainly produced from rock-oils by polymerization of certain constituents of such oils under the influence of the air, or of the sun's rays, or of both, together with the influence of acid, saline or other polymerizing agents incidentally present."

"It remains to be added, however, that there is ample evidence of spontaneous polymerisms of many native carbohydrogen liquids, as in the case of Hofmann's bromine compound, by mere lapse of time, without the influence of other agency than that of temperature."

The contributor desires to call the reader's attention to the remarkable molecular changes which take place in petroleums by the addition to them of soda preparations, soap, etc., whereby a small portion of the influencing material converts the oil into solids, or semi-solids, enabling the petroleum to be transported as solid merchandise, and even to be burnt in grates in place of coal. All these phenomena are interpreted by him as cases of polymeric changes, many of which are reversible. The general inference is that many of the changes seen in the treatment of asphalt are of like nature, and reversible to such an extent that it is incredible that we can not learn to so manipulate an asphalt as to restore its former state of adaptability to our needs. *Dolphus Torrey.*

DOLPHUS TORREY.

DIAGRAMS FOR THE DISCHARGE OF CIRCULAR SEWERS.

THE diagrams published in this number of PAVING AND MUNICIPAL ENGINEERING have been carefully drawn from recalculated data, using Kutter's formula, with a co-efficient of roughness (n) of .013. The Kutter formula is an adaptation of the well-known Chezy formula:

$$v=c\sqrt{r.s.}$$

when r=the hydraulic mean depth or the area divided by the wet perimeters of the channel.

s=sine of inclination or slope of channel, or the head divided by the length of channel.

c=coefficient which varies with the conditions, form and dimensions of the channel and with the head, and

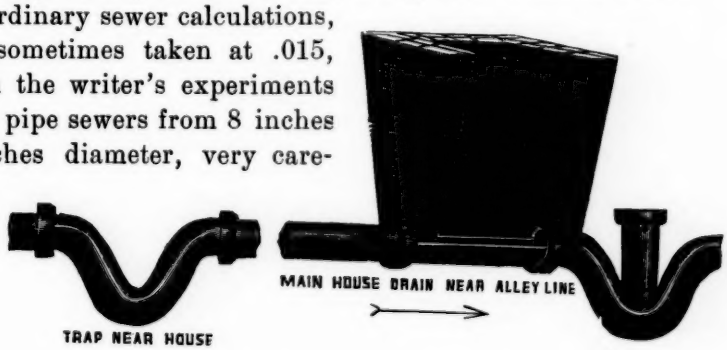
S=mean velocity, in feet per second.

In the Kutter formula the coefficient, c, is obtained by the following expression:

$$c=\frac{41.6+\frac{1.811}{n}+\frac{.00281}{s}}{1+(41.6+\frac{.00281}{s})\times\frac{n}{\sqrt{r}}}$$

Where "n"=coefficient of roughness, which ranges from .009 for a channel of planed boards to .035 for a rough open channel obstructed by weeds, as for instance, a neglected ditch or canal.

For ordinary sewer calculations, "n" is sometimes taken at .015, but from the writer's experiments on some pipe sewers from 8 inches to 18 inches diameter, very carefully laid, "n" for first-class pipe sewers, should be taken at .013, and well-built brick sewers will give a discharge when new and clean, due to "n," .013. In using the diagrams it should be borne



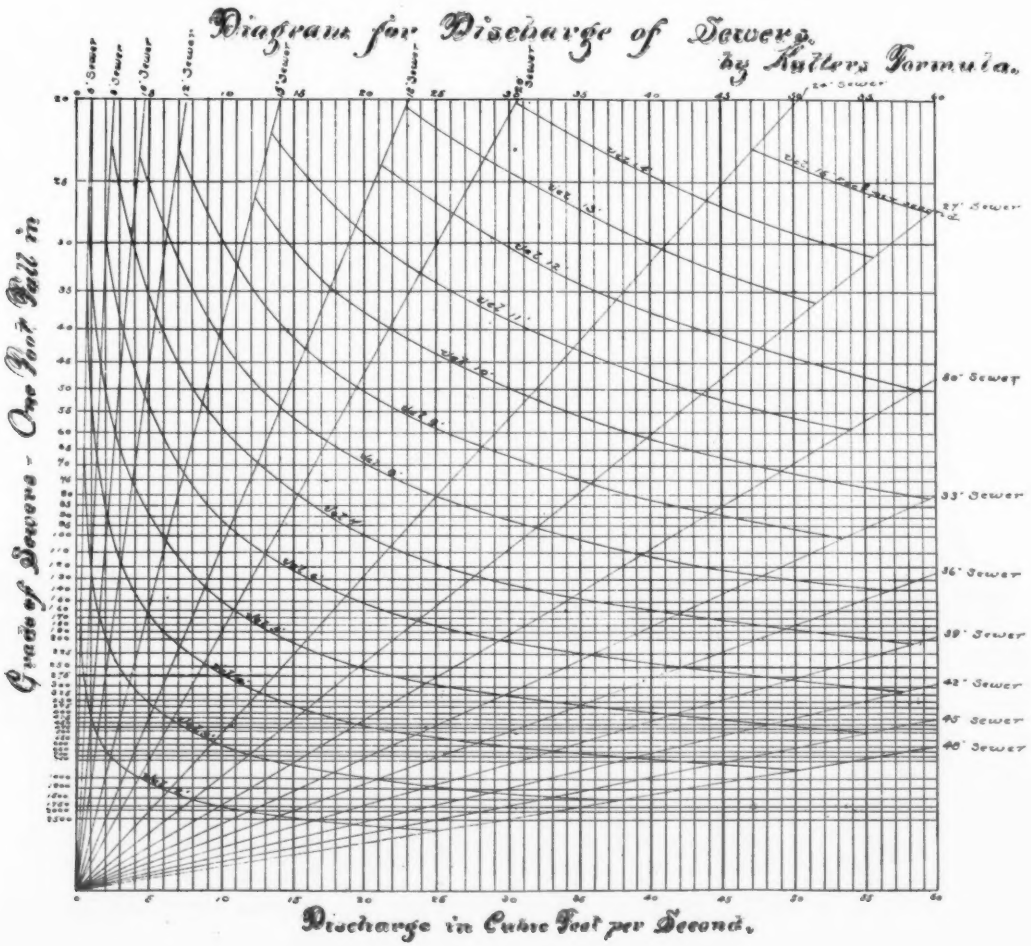


Diagram for Discharge of Sewers.
by Kutters Formula.
Grade of Sewers - One Foot Fall in
Discharge in Cubic Feet per Second.
6" Sewer
9" Sewer
12" Sewer
15" Sewer
18" Sewer
21" Sewer
24" Sewer
27" Sewer
30" Sewer
33" Sewer
36" Sewer
39" Sewer
42" Sewer
45" Sewer
48" Sewer
Vel. 1 ft.
Vel. 2 ft.
Vel. 3 ft.
Vel. 4 ft.
Vel. 5 ft.
Vel. 6 ft.
Vel. 7 ft.
Vel. 8 ft.
Vel. 9 ft.
Vel. 10 ft.
Vel. 11 ft.
Vel. 12 ft.
Vel. 13 ft.
Vel. 14 ft.
Vel. 15 ft.
Vel. 16 ft. per sec.

in mind that the velocities and discharges are what can be expected *only with the best quality of sewer construction*.

The following explanation will enable any one to use the dia grams with facility. The horizontal lines represent the grades of sewers, and these range on diagram No. 1, from a fall of one foot in 20 feet to a fall of one foot in 2,500 feet; and on diagram No. 2, from a fall of one foot in 25 feet, to a fall of one foot in 10,000 feet.

The vertical lines represent the discharge of sewer in cubic feet per second when running full; on diagram No. 1, this is carried from 0 to 60 cubic feet, and on diagram No. 2, from 0 to 800 cubic feet.

The angular lines represent the sewers of diameters from 6 inches to 10 feet, and the curved lines indicate the velocity of flow in feet per second for sewer running full or half full.

To use the diagrams, let it be desired to know the velocity and discharge of a 24-inch pipe sewer, laid at a grade or fall of one foot in 400, and running full bore, refer to diagram No. 1, follow down the column of figures at the left of the diagram until 400 is reached, then trace the horizontal line to the right until it intersects the angular line marked 24-inch sewer at the top of diagram, when the discharge will be noted in 11.3 cubic feet per second, and the velocity 3.6 feet per second.

Again, an 8-inch pipe sewer is intended to discharge 1.5 cubic feet per second, what grade must it have, and what will be the velocity of flow? Follow the vertical space between the lines indicating a discharge of 1 and 2 cubic feet per second (at the left of diagram No. 1) until the diagonal line marked at the top of diagram, 8-inch sewer, crosses the space at about one-half the distance between the lines, when it will be noticed that the grade for a discharge of 1.5 cubic feet per second for this diameter of sewer will be 1 foot fall in 55, and the velocity for a sewer running full, or half full, will be about 4.3 feet per second.

Referring to diagram No. 2, a brick sewer 8 feet in diameter is built on a grade or inclination of 1 foot in 1,500. What will be the velocity of flow when running full or half full, and the discharge when running full? velocity, 4.8 feet per second; discharge, 243 cubic feet per second.

A sewer which can be laid at an inclination of 1 foot in 500 is

required to discharge, when running full, 150 cubic feet per second. The sewer will be 5 feet 6 inches diameter, and will have a velocity of flow of 6.3 feet when running full or half full.

The diagrams give the four variables in sewer calculation, viz., diameter, grade or slope, velocity of flow and discharge.

John W. Hill, Cons. Eng.

OIL RESIDUUM IN ASPHALTIC PAVING COMPOSITIONS.

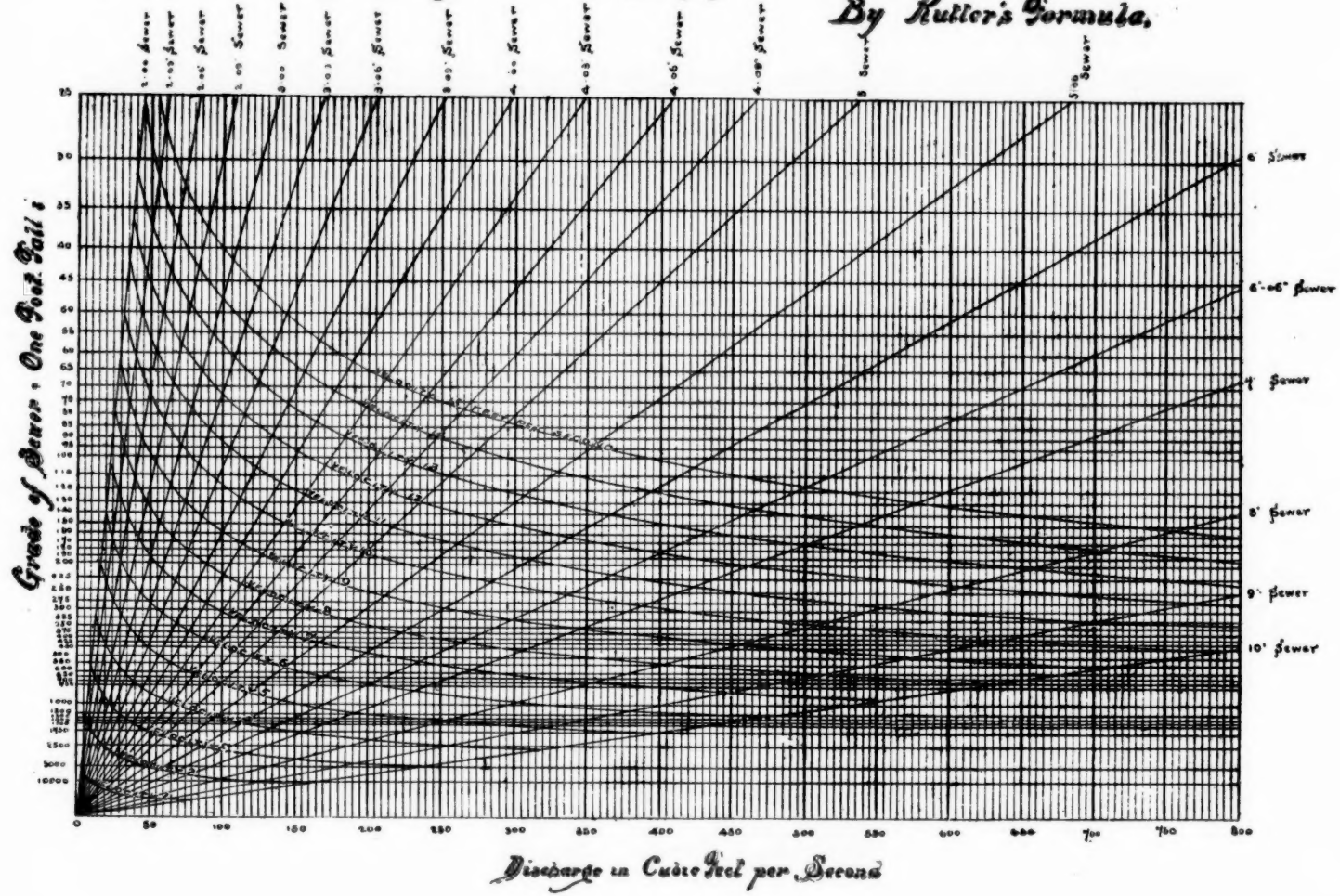
In studying the results of recent experiments and tests made upon asphalt paving compositions for the Citizens' Municipal Association and Trades League of Philadelphia, it has seemed to us, that better, stronger and more durable paving compositions could be made with the two asphalts, Trinidad and Bermudez than were made then. In making up the compositions at that time, the materials taken for admixture with the asphalts were those furnished by the two Philadelphia companies using the above-mentioned asphalts and the proportions used were those recommended by them. No attempt was made at that time to ascertain whether, for instance, the oil residuums used for tempering the asphalt were the best that could be used for the purpose, nor was the question of the thoroughness of their blending with the solid asphalts specially considered. We were inclined, however, at the time of the publication of that report to believe that the oil residuum was likely to be the weak element in the combination, partly because of its varying character, but mainly because we were convinced that the mixture was only a loose mechanical one that would not stand atmospheric influences and exposure to extremes of temperature.

That the blending of the asphalt and the oil-residuum is an unsatisfactory one on the score of its lack of durability we have since found from conversation with practical men of many years' experience in asphalt paving to be a common belief. It is also admitted by the chief writers on the subject of asphalt paving that the quality of an asphalt is reduced in the ratio of the percentage of increase of petroleum oil used. Hence the care now exercised in choosing the best quality of Lake asphalt in which the natural oils still remain and rejecting the land asphalt which has lost these asphaltic oils in large degree.

There are two methods by which the use of the petroleum re-

Diagram for Discharge of Sewers.

By Kutter's Formula.



siduum in asphalt paving mixtures can be done away with; one is to find natural asphalts which retain sufficient of their original asphaltic oils to make it possible to use them with no other admixture than the proper amounts of sand and pulverized limestone; the other is to mix with the hard natural asphalts, liquid natural asphalts, of which a number are now found on the Pacific coast, and in Utah, Idaho, Montana and elsewhere in the West. To these two alternatives may perhaps be added a third, viz: to find some artificial flux or tempering material which will make a more perfect and durable blend with the solid asphalts than that obtained with oil residuum.

As yet we do not know of a natural asphalt that can be used for paving compositions without fluxing, unless it be some of the natural rock asphalts. While some of the European asphaltic limestones are capable of being used for paving without addition of fluxing material, they have not been found to make as satisfactory pavements as those containing a siliceous base. The natural asphaltic sandstones of California are used frequently, it is stated, for paving purposes without admixture of foreign fluxing material, but they are not available for use with us east of the Rocky mountains.

We turn then to the second method of making a paving composition which shall do away with the necessity for the use of the oil residuum, viz: to flux the solid asphalt with the natural liquid asphalt. This has been done already in California with excellent results, it is claimed, by the California Petroleum and Asphalt Company, who offer what is known as "Alcatraz Liquid Asphalt" for this purpose. As no figures have been published by which one can judge of the reliability of these claims, it was determined to make a study of the paving compositions that could be made with the liquid asphalts used as tempering material for the solid asphalts. We therefore procured a quantity of the liquid Alcatraz asphalt through the courtesy of Mr. Willard Barton, manager of the California Petroleum and Asphalt Company, and from other sources, a specimen of liquid asphalt from Utah. At the same time we concluded to try also an artificial fluxing material which is offered as a substitute for oil-residuum in the making of asphalt paving compositions. These three materials it was determined to try as substitutes for oil residuum in making paving compositions, using as a base the two

standard asphalts now in common use, refined Lake Trinidad and refined Bermudez asphalt.

In order to have a clear understanding of the nature of these materials and how their addition would effect the composition of the finished mixture, it was thought desirable to make a partial chemical analysis of them, determining the amount of bitumen contained and its quality.

An analysis of the liquid Alcatraz asphalt has been made by Thomas Price & Son, of San Francisco, Cal., and is published by the California Petroleum and Asphalt Company in a pamphlet issued by them. Our analysis substantially confirms the figures there given.

Our figures were:

Specific gravity of the liquid Alcatraz asphalt	1.050 p. c.
Total bitumen soluble in carbon disulphide	98.70 p. c.
Organic non-bitumen	trace.
Mineral matter	1.30 p. c.
Bitumen soluble in petroleum naphtha	89.17 p. c.

The Utah liquid asphalt used by us was also analyzed. It was in a crude state and had not been refined in any way, so that small fragments of vegetable debris showed here and there in it. The results of the analyses were:

Specific gravity of the liquid Utah asphalt	.9068 p. c.
Total bitumen soluble in carbon disulphide	76.15 p. c.
Organic non-bitumen	20.45 p. c.
Mineral matter	3.40 p. c.
Bitumen soluble in ether	64.90 p. c.
Loss at 100 C	24.72 p. c.

The asphaltic fluxing material was not analyzed by us. The analysis published by the company who manufacture it is as follows:

Total bitumen soluble in carbon disulphide	99.32 p. c.
" " " " ether	65.00 p. c.

In preparing these asphalt mixtures for physical tests the ingredients were carefully weighed in the proportions given in the tabulated statement. To the asphalt mixture, when at 300 F., was added the mixture of fine sand and pulverized limestone heated to the same temperature; when the whole had been mixed to a homogeneous mass, no appreciable fall of temperature being allowed during the mixing, it was molded into briquettes and cubes. Everything used in this work, molds, rammers and trowels, was kept hot so as to conform as far as possible to the practice of making and

laying asphalt pavements. Each mixture was subjected to the same amount of work so that the results might be comparable.

The tensile test specimens were made in cement briquette molds and tested after they had stood at least 24 hours (those for the tests of 32 F. having been placed in a receptacle surrounded by melting ice), on a 2,000-lb. cement testing machine with automatic speed regulator. The compression test specimens were two inch cubes tested on a 100,000-lb. testing machine, with automatic registering beam. The penetration tests were made on the broken briquettes after they had stood at the normal temperature for from two weeks to two months, by forcing into them a ¼ cast-iron punch and recording the maximum load on the beam of the machine. This punch was made by turning down, to the desired diameter, one end of a 1⅜ inch cast-iron rod, the object being to have a large bearing surface against the compression face of the machine, so that the punch might always enter the briquette perpendicularly.

It is not the idea of the writers to claim any advantages for this method of penetration over that of the needle method, as the objects of the two are entirely dissimilar, one being to test the paving mixture when it is being made, the other to test the bearing qualities of the mixture after it has been laid some time.

The series of tensile and compression tests of asphalt mixtures which appeared in the report before referred to marked a new departure. No criterion had ever been established for such tests of asphalt and such work as had been done was tentative and inconclusive. The tests met with some criticism, chiefly because no such criterion had been established. The writers of the present paper, who made the tests referred to, were, however, very well satisfied that the data furnished by such tests were very valuable and formed a basis of scientific comparison in marked contrast to some of the crude and vague criteria which have been suggested. The method of preparation of asphalt mixtures in a semi-fluid condition made it practicable and easy to mold briquettes and cubes for testing, just as is done with hydraulic cements. Asphalt is a cement of remarkable properties, showing in well-proportioned mixtures much greater cementitious powers than hydraulic cements. As shown by the tests reported herewith mixtures which contain 10 per cent. of pure asphalt have given tensile tests as high as 1,000

pounds per square inch. Regardless, therefore, of other functions required in a paving mixture, it is perfectly clear that the cementitious properties of asphalt mixtures can be determined by tensile tests. And by similar reasoning the bearing powers of asphalt pavements can be determined by compression tests.

So much may be, and evidently must be, freely granted, but having made a series of comparative tests on this basis, are we justified in concluding that the mixture showing the highest tensile and compression tests is the best mixture? Other things being equal, yes, and this is especially and particularly true of comparative tests at the higher temperature because the hot weather is a major factor in the construction of asphalt pavements. What, then, are the "other things"? Evidently in the first place the mixture must be one that works easily and freely in preparation and which will mold to a compact body and good surface in laying. In the second place the mixture must show at all ordinary temperatures a quality of toughness which shall distinguish it sharply from the brittle and friable quality of stone or hydraulic concrete. These things being equal it is the judgment of the writers that the better the tests the better the mixture.

Direct tensile and compression tests of materials may now be regarded as the standard physical tests, having superseded the others to a great degree, because we are able mathematically to deduce other functions from them. The penetration tests were added because it was thought they might aid in confirming the general results of the other tests.

In penetration tests there are two factors: compression of the area covered and shearing on the edges. For this reason simple penetration tests have not been generally found useful in testing materials. A number of such tests have been tried with metals, but no basis of comparison has been arrived at. The fact is that none can be unless it should be by the aid of a work diagram, and for paving mixtures a test of a work diagram would be a refinement. Hence the writers attach no special importance to penetration tests as a basis of comparison or a method, but to confirm a general impression they have found them useful.

SUMMARY OF RESULTS OF PHYSICAL TESTS.

I. Refined Trinidad and Liquid Alcatraz Asphalts.

Percentage composition of the mixture—

Refined Trinidad	12.5 per cent.
Liquid Alcatraz	2.5 " "
Fine sand	58.0 " "
Pulverized limestone	27.0 " "
	100.0

Cohesion Tests.

At 82° F.	At 73° F.	At 82° F.
No. 5. 900 lbs.	No. 3. 490 lbs.	No. 7. 336 lbs.
No. 6. 800 lbs.	No. 4. 425 lbs.	No. 8. 315 lbs.
No. 1. 832 lbs.	Average, 457.5 lbs.	Average, 325.5 lbs.
No. 2. 732 lbs.		
Average, 816 lbs.		

Compression Tests.

At 32° F.	At 73° F.
Cube No 1. 29360 lbs.	Cube No. 2. 10900 lbs.
Per sq. inch, 7340 "	Per sq. inch, 2725 "

Penetration Tests.

Temperature, 82° F.

Briquette,	No. 1.	830 lbs.=16.940 lbs.	per	square	inch.	
"	" 2.	815 lbs.=16.630	"	"	"	"
"	" 5.	720 lbs.=14.690	"	"	"	"
"	" 8.	860 lbs.=17.560	"	"	"	"

II. Refined Bermudez and Liquid Alcatraz Asphalts.

	Mixture No. 1.	Mixture No. 2.	Mixture No. 3.
Refined Burmudez	9.0 per cent.	9.0 per cent.	9 per cent.
Liquid Alcatraz	2.5 " "	1.5 " "	2 " "
Fine sand	67.33 " "	60.0 " "	60 " "
Pulverized limestone	21.17 " "	29.5 " "	29 " "
	100.00 " "	100.0 " "	100 " "

Cohesion Tests.

At 32° F.	At 73° F.	At 82° F.
(Mix. No. 1) No. 9. 854 lbs.		(Mix. No. 1) No. 11. 167 lbs.
No. 10. 720 "		No. 12. 170 lbs.
(Mix. No. 2) No. 5. 869 "	(Mix. No. 2) No. 7. 396 lbs.	
No. 6. 830 "	No. 8. 435 "	
	At 79° F.	
(Mix. No. 3) No. 14. 986 "	(Mix. No. 3) No. 16. 325 "	
No. 15. 981 "	No. 17. 380 "	
	No. 18, 370 "	

Compression Tests.

At 32° F.	At 73° F.	At 79° F.
(Mix. No. 2.)	(Mix. No. 2.)	
Cube No. 3. 25.860 lbs.	Cube No. 4. 8450.0 lbs.	
Per sq. in., 6.465 "	Per sq. in., 2112.5 "	
(Mix. No. 3.)	(Mix. No. 3.)	
Cube No. 4. 25640 lbs.		Cube No. 5. 6000 lbs.
Per sq. in., 6410 "		Per sq. in., 1500 "

Penetration Tests.

Temperature 82° F.

Mixture No. 1.	Briquette No. 11.	540 lbs.	=10.610	per square inch.
" " "	" " 12.	510 "	=10.410	" " "
Mixture No. 2.	" " 5.	570 "	=11.630	" " "
" " "	" " 6.	720 "	=14.690	" " "
Mixture No. 3.	" " 15.	545 "	=11.120	" " "
" " "	" " 17.	650 "	=13.265	" " "

III. Refined Trinidad and Liquid Utah Asphalts.

Percentage composition of the mixture:

Refined Trinidad	12.5 per cent.
Liquid Utah	2.5 " "
Fine sand	58.0 " "
Pulverized limestone	27.0 " "
	100.0

Cohesion Tests.

At 32° F.		At 79° F.	
Briquette No. 6.	710 lbs.	No. 8.	435 lbs.
" No. 7.	755 lbs.	No. 9.	370 lbs.
Average,	732.5 lbs.	Average,	402.5 lbs.

No compression tests made.

Penetration Tests.

Temperature 82° F.

Briquette No. 6, 750 lbs.=15.310 lbs per square inch.
" No. 8, 930 lbs.=18.980 " " " " "

IV. Refined Bermudez and Liquid Utah Asphalts.

Percentage composition of the mixture:

Refined Bermudez	9 per cent.
Liquid Utah	2 " "
Fine sand	60 " "
Pulverized limestone	29 " "
	100 " "

Cohesion Tests.

At 32° F.		At 79° F.	
Briquette No. 10.	968 lbs.	No. 12.	440 lbs.
Briquette No. 11.	1035 lbs.	No. 13.	390 lbs.
Average,	1001.5 lbs.	Average,	415 lbs.

Compression Tests.

At 32° F.

Cube No. 4. 22.150 lbs.
Or per square inch, 5537.5 lbs.

Penetration Tests.

Temperature 82° F.

Briquette No. 10.	700 lbs.	=14.285	lbs. per	square inch.
" " 12.	770 lbs.	=15.710	" "	" "
" " 11.	880 lbs.	=17.960	" "	" "

V. Refined Trinidad Asphalt and Special Flux.

Percentage composition of the mixture:

Refined Trinidad asphalt	12 per cent.
Special flux	3 " "
Fine sand	58 " "
Pulverized limestone	27 " "
	100 " "

Cohesion Tests.

At 32° F.		At 83° F.	
Briquette No. 1.	440 lbs.	No. 3.	215 lbs.
" " 2.	350 lbs.	No. 4.	203 lbs.
Average,	395 lbs.	Average,	209 lbs.

Compression Tests.

At 32° F.	At 83° F.
Cube No. 1. 4550 lbs.	Cube No. 2. 2750 lbs.
Or per sq. inch, 1137.5 lbs.	Or per sq. inch 687.5 lbs.

Penetration Tests.

Temperature 82° F.

Briquette No. 1. 490 lbs.=10.000 lbs. per sq. inch.
" " 4. 600 lbs.=12.245 " " " "

VI. Refined Bermudez Asphalt and Special Flux.

Percentage composition of the mixture:

Refined Bermudez asphalt	9	per cent.
Special flux	2	" "
Fine sand	60	" "
Pulverized limestone	29	" "
	100	" "

Cohesion Tests.

At 32° F.		At 83° F.	
Briquette No. 6.	335 lbs.	No. 8.	206 lbs.
Briquette No. 7.	330 lbs.	No. 9.	221 lbs.
Average,	332.5 lbs.	Average,	213.5 lbs.

No compression tests made.

Penetration Tests.

Temperature 82° F.

Briquette No. 6. 330 lbs.=6.735 lbs. per square inch.
Briquette No. 7. 410 lbs.=8.367 lbs. per square inch.

VII. Penetration Tests on the Briquettes Containing Oil Residuums:

Described in "Report on Asphalt Paving Compositions," published by the Citizens' Municipal Association and the Trades League of Philadelphia.

(1) Mixture of Trinidad asphalt and oil residuum:

Refined Trinidad asphalt	12.5	per cent.
Oil residuum	2.5	" "
Fine sand	58.0	" "
Pulverized limestone	27.0	" "
	100.0	" "

Result of Tests.

Temperature 82° F.

Briquette No. 1. 80 lbs.=1633 lbs. per sq. inch.
" No. 2. 70 lbs.=1426 " " " "
" No. 3. 60 lbs.=1225 " " " "
" No. 4. 140 lbs.=2858 " " " "
" No. 5. 60 lbs.=1225 " " " "
" No. 6. 90 lbs.=1837 " " " "

(2) Mixtures of Bermudez asphalt and oil residuum:

	Bermudez No. 1.		Bermudez No. 2.	
Refined Bermudez asphalt	9.1	per cent.	9.1	per cent.
Oil residuum	1.0	" "	1.0	" "
Find sand	75.0	" "	60.0	" "
Pulverized limestone	15.0	" "	30.0	" "
	100.1	" "	100.1	" "

Results of Tests.

Temperature 82° F.

Briquette No. 7. 290 lbs.=5915 lbs. per sq. inch.
" No. 8. 290 lbs.=5915 " " " "
" No. 9. 240 lbs.=4898 " " " "
" No. 10. 210 lbs.=4286 " " " "
" No. 11. 220 lbs.=4490 " " " "
" No. 12. 250 lbs.=5100 " " " "
" No. 13. 240 lbs.=4898 " " " "
" No. 14. 260 lbs.=5305 " " " "
" No. 15. 260 lbs.=5305 " " " "
" No. 16. 280 lbs.=5716 " " " "
" No. 17. 280 lbs.=5716 " " " "
" No. 18. 280 lbs.=5716 " " " "

(3) Penetration tests on two briquettes of Cranford Paving Co. composition: (See Asphalt Report, p. 17.)

Briquette No. 1. 220 lbs.=4490 lbs. per sq. inch.
" No. 2. 260 lbs.=5305 " " " "

The results of compositions I and III should be compared with those obtained with the Trinidad asphalt and oil residuum mixture tested in the Citizens' Association report. The compositions only differ in that, instead of 2½ per cent. of oil residuum, the same amount of a liquid asphalt has been used. In composition V, 3 per cent. of flux was used instead of 2½ of oil residuum, the percentage of solid natural asphalt being reduced correspondingly.

In the case of Bermudez asphalt and liquid Alcatraz, we started with what seemed on examination of the briquettes to be too high a percentage of the liquid asphalt, and we reduced it, first to 1½ per cent., and then found that 2 per cent. was rather better. All the results are given however.

The mixture of Bermudez asphalt and liquid Utah asphalt gave us what seemed to be the maximum cohesive strength, and the penetration test tried on the same briquette was also high. This mixture was very hard at ordinary temperatures but not brittle. The fracture of the broken briquette was a clean one, not ragged. For comparison with the penetration tests obtained with these new mixtures, we made corresponding tests with the broken briquettes from the tests made last May for the Citizens' Association which had been carefully preserved. The results are given, together with the composition of the mixtures used at that time. The numbers of the briquettes are the same as given in the original report.

With all these figures before us, it is not difficult to reach the conclusion spoken of at the beginning of our paper as already foreshadowed, viz: that better, stronger, and in all probability, more

durable paving compositions can be made than those now being made with the aid of oil residuum. Of course the test of time is necessary to settle the question of durability, but it must be remembered that we are suggesting the substitution of a natural product for an artificial one and one of composition similar to the solid asphalt base for one, the composition of which is distinctly different.

Samuel P. Sadtler.
J. Edward Whitfield.

PROF. SAMUEL P. SADTLER, whose name appears in connection with this article, was, it will be remembered, one of the two chemical experts who were selected by the Citizens' Municipal Association and the Trades League of Philadelphia last spring to investigate the subject of asphalt paving with reference to work in that city. While his name may be new to our readers in this connection, it is well known in scientific circles. Besides numerous scientific papers and addresses, he is the author of a "Handbook of Industrial Organic Chemistry," which has had a wide circulation in this country and in England, and has also been translated and published in Germany. He has also been for the past fourteen years the chemical editor of the United States Dispensatory. He was connected with the University of Pennsylvania for many years as professor of Organic and Industrial Chemistry and is now professor of Chemistry in the Franklin Institute and in the Philadelphia College of Pharmacy. For some years past he has devoted much time to practice as consulting chemical expert in chemical patent cases and the investigation of new chemical processes and products for manufacturers. He has in particular made a study of petroleum and its products for the past twenty years, and is well known in that connection. He was born in 1847, took his S. B. degree at Harvard University in 1870, and the Ph. D. degree at Göttingen, Germany, in 1871, since which time he has been continuously engaged in chemical teaching and work.

MR. J. EDWARD WHITFIELD was born in Albany, N. Y., in 1859. His father is Prof. R. P. Whitfield, the well known paleontologist, now of the American Museum of Natural History in New York. Mr. Whitfield was educated at the Renssalaer Polytechnic Institute, and, joining the U. S. Geological Survey in 1880, remained attached to it until 1888, with the exception of one year when he had charge of a corps in practical engineering under the Northern Transcontinental Survey. In 1888 he joined the firm of Booth, Garrett & Blair, analytical chemists and engineers, of Philadelphia. Mr. Whitfield is the author of various brochures on the analysis of meteorites, waters, etc.

BRICK PAVEMENTS IN ROCK ISLAND, ILL.

ABOUT five or six years ago the streets of Rock Island got into such bad shape that a revolution in paving operations became necessary. With this for a primary object a number of our public-spirited citizens formed an Improvement Association, and one of their first achievements was the inauguration of brick paving.

The first contract let by the city council was for six blocks of two-course paving, the bottom of building brick, and the top of paving brick, laid as follows: First the ground is shaped and rolled and then six inches of broken rock put on; this was covered with

sand, flushed and rolled with a horse roller and again covered with a three-inch layer of sand; on this was placed a course of brick, laid flat; this foundation was covered with a one-inch cushion layer of sand and a layer of brick on edge, with sand swept into the interstices. Some of this has settled more or less unevenly, but the greatest trouble has been where the street was dug up just ahead of the paving for service pipes, etc., and where the electric street car company economized on ties; their track became so low and uneven that last summer they had to take up between three and four blocks, raise it and relay with double the number of ties originally used. In doing this work it was found that the building brick in the lower course were so badly disintegrated after three years' use that few of them could be replaced whole.

Until last summer all of our paving was of two courses, laid as above, with the exception that either first or second quality brick was used in the bottom course. In 1893, however, we laid all single course under the same specifications, except that we used a ten-ton steam roller on the foundation. This exception will, I think, go far toward preserving the paving, as the irregular settling has troubled us more or less where the light horse roller was used in preparing the foundation; but so far none of last summer's work has settled unevenly, though in places the dirt fill under the rock was two feet or more, and many service pipes and a gas main, twenty blocks long, were put in just ahead of the paving.

The plumbers here are required to guarantee their ditches from settling for ninety days; this gave some of them a little experience when the first paving was done, and since then they have thoroughly tamped their back filling; for the last two years there has been little or no settling from this cause, but whether to lay it all to thorough tamping or not, I do not know.

Almost the first paving done last spring had a gravel subsoil, and I had a small section laid without any rock in the foundation; there is not travel enough over this section to give it a thorough test, but so far it has stood as well as where the macadam foundation was used.

Our oldest paving has been down nearly five years; the bricks have the corners rounded off, but are not seriously worn otherwise, and there are no ruts, except in one place where heavy coal teams pass from the cars to the scales.

The money for the improvements has been raised by special taxation against the abutting property and by special assessment against the street car companies where they did not make their own contracts. Only a small proportion has been payable in cash, most of the collection being on the five-year installment plan. Out of the first installment is paid all court costs, engineering and other expenses, and the balance paid to the contractor; warrants are then issued to the contractor against the other four installments, which bear interest at 6 per cent.

Materials at Rock Island cost about as follows:

Rock (unbroken, delivered)	$ 1.10 per cubic yard.
Sand (on barge)	.25 " " "
First quality brick	10.00 to $11.00 per M.
Labor	1.50 to 1.75 " day.
Excavation (in clay)	.25 per cubic yard.

With these prices our paving has cost for Galesburg brick, top and bottom, $1.68 to $1.75 per square yard, and Rock Island brick $1.58 to $1.65. All of our single course paving, except two blocks, has been done with Rock Island brick, at a cost of $1.30 and $1.31 per square yard. The grading is included in the above prices.

We now have five and a quarter miles of double course and one and three-quarter miles of single course paving.

W. A. Darling.

CURRENT INFORMATION.

STREET CLEANING IN ST. PAUL.

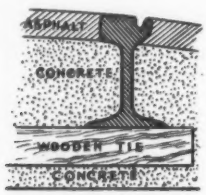
It cost the city of St. Paul last year $13,766.97 to clean 1,587.39 miles of streets, or $8.67 per mile. It is thought probable that it will cost a trifle more this year. From May 10 to November 30, a force of men, from fifty to sixty in number, are employed to drive the sweepers and wagons and shovel the refuse into wagons and cart it away to the dumping places. The force consists of eighteen teamsters, who furnish their own teams and are paid $3.25 per day; thirty-six shovelers who load the piles of refuse into the wagons, at $1.60 per day; three foremen, at $2.10 per day; an inspector whose salary is not named. The city has in service six sweepers and twelve wagons, and there is a force of clerks in the office of the city engineer, beside dump-inspectors and time-keepers. The streets are gone over by the sweepers, which are followed by the wagons and the refuse shoveled from the gutters into the wagons. When one wagon is loaded it is driven to the dumping place and another wagon follows to take its place. The men work all night. Around the business centers of the city the streets are swept every night. The paved streets extending out from the business center and the driveways are swept twice every week. An effort is always made on Saturday night to sweep and clean the streets in all parts of the city, so that its appearance will be cleanly and pleasing to the many people who drive on Sunday.

STREET RAILWAY TRACKS AND ASPHALT PAVEMENTS.

The paving material question has been settled at St. Paul, Minn., by the property owners on the streets of proposed improvements, deciding on asphaltic paving, from curb to curb. The street-car company, however, opposes asphalt between the rails, claiming that the frequent repairs of wires joining the rails would necessitate tearing up the pavement, and putting it down again would be very expensive. In an interview regarding the subject, an expert visiting the city, in giving a description of the way that electric street-car roads were constructed in cities where asphalt paving is used, said:

"As a result of years of experience in the city of Cincinnati, the board of administration and the city engineer have agreed upon a construction for double-track electric street railway lines. First, the street is excavated to a depth of eighteen inches below the top of the rail when the street is completed, and for a width of eighteen feet in the bottom of this trench is placed a layer of hydraulic cement concrete six inches in depth. On the top of the concrete the ties are placed, two and a half feet from center to center. The ties are eight feet long, six inches in depth and seven inches wide, except the joint ties, which are ten inches wide. The ties are of the best white-oak. To these ties the rails are spiked by four spikes at each tie. The rail used is of special sec-

tion, weighing eighty-two pounds per yard, six inches high, having a six-inch base, and being of the kind known as full-grooved rail. After all the joints are securely bolted together, and the electrical



connections put in, the track is carefully lined and surfaced, fresh concrete and mortar thoroughly tamped under the ties, and the concrete is then built up to within two and a half inches of the finishing surface of the street, being thoroughly packed around the ties and under the base of the rail. After the concrete has become thoroughly hardened, so as to bear the weight of the steam roller used to compact the asphalt, the asphalt surface, two and a half inches thick, is put on the street.

"In a track constructed this way, where the full-grooved rail is used, the asphalt is laid directly against the rail and even with its top. The rails offer but slight obstruction to travel on the street, there being nothing but the slight groove in the top of the rail to catch the wheels of vehicles. This kind of track is practically permanent, and should require little or no repairs of any kind until the rails or ties are worn out. The saving in repairs is so great that the construction is the most economical one, notwithstanding the greater first cost. The track being perfectly firm, does not injure the pavement by vibration nor by sinking under the weight of the cars.

"The practice of putting a hydraulic concrete foundation under the ties is not carried out in all cities. In many a foundation of crushed stone eight inches in depth, thoroughly compacted by a heavy steam roller, is used instead of the concrete. This makes a very satisfactory foundation and costs considerably less than concrete. The ties, rails and method of laying and fastening them are practically the same in both cases.

"The earlier electric railroad tracks were constructed in a light and temporary manner. Rails of the ordinary street railroad pattern, weighing from forty to fifty pounds per yard, were spiked upon longitudinal wooden stringers, which in turn rested upon cross-ties placed from five to seven feet apart. Such track did very well for the light horse cars for which it was intended to carry, but it was soon found that the heavier motor cars, comparatively light as these were when first introduced, soon destroyed the track constructed in this way. Then a heavier rail of the girder pattern was substituted, spiked directly to the cross-ties, which were placed a little nearer together. But in the meantime the weight and power of the motor cars were continually increased until this style of track became entirely insufficient for the service required of it, and was soon destroyed or driven down into the soft soil upon which the ties were laid. Depressions occurred at every joint in the rails, so that the track soon became very rough and very destructive to the cars and delicate machinery of the electrical motor. Not only this, but the constant shaking and oscillation of the track under the weight of the heavy cars soon destroyed the electrical connections between the rails, rendering almost constant repairs necessary, which repairs necessitated the tearing up

of the street pavement in order that they might be made.

"It is found as the result of experience that the modern electric motor car when loaded from platform to platform with passengers, the whole weight resting upon four wheels placed near together, is almost as destructive upon a track as the steam locomotive, and consequently requires a track having the same substantial construction as the modern steam railway track. The steam railroads of the country have passed through a similar experience in their development. In place of the light iron strap rail spiked to wooden stringers we now have the magnificent modern railway track with rails weighing from 90 to 100 pounds per yard, spiked to ties closely spaced and resting upon a bed of ballast composed of sand or broken stone from one to two feet in depth. And the tendency is constantly towards still heavier and more substantial construction. In the same manner the electric railway companies are finding that the earlier forms of construction are proving entirely insufficient for the requirements and the tendency is constantly toward a heavier and more substantial construction of their tracks. And this for the reason that in the end first-class, permanent work is the most economical.

"Of course, a track constructed in the substantial manner outlined is expensive, and few companies in these hard times feel able to make the large expenditures necessary. Many of the companies in the present condition of their business feel that they can not afford such large sums of money, even if it is clear to them that it would be most economical in the end. And as the interests of the street railway companies and those of the citizens are the same in the end, it is right that the railroad companies should have proper consideration in the carrying out of public improvements which affect the interests of both."

DESTRUCTION OF UNDERGROUND PIPES BY ELECTRIC CURRENTS.

Managers of electric railway systems are confronted by a serious foe in the form of electrolysis. Mr. I. H. Farnham, of Boston, was the first person to call the public's attention to the destructive effects upon gas and water mains of electricity diffused through the ground. Reports are recorded from cities throughout the country where electric roads have been in operation for a period varying from six months to a year, and some instances are cited of the destruction of new service pipes in one month's time, of the serious damage to underground pipes caused by electrolysis.

Electrical experts seem to favor the adoption of a plan of complete metallic circuit, or the welding of the rails so as to form one continuous metallic conductor. Mr. Farnham, in a recent address before the American Institute of Electrical Engineers, gave, as a number of facts and experiments known to him by personal investigation, the following:

First. **All single trolley railways employing the rails as a portion of the circuit cause electrolytic action and consequent corrosion of pipes in their immediate vicinity, unless special provision is made to prevent it.**

Second. **A fraction of a volt difference of potential between pipes and the damp earth surrounding them is sufficient to induce the action.**

Third. **Bonding of rails, or providing a metallic return conductor equal in sectional area and conductivity to the outgoing wires, is insufficient to wholly prevent damage to pipes.**

Fourth. **Insulating pipes sufficiently to prevent the trouble is impracticable.**

Fifth. Breaking the metallic continuity of pipes at sufficiently frequent intervals is impracticable.

Sixth. It is advisable to connect the positive pole of the dynamo to the trolley lines.

Seventh. A large conductor extending from the grounded side of the dynamo entirely through the danger territory and connected at every few hundred feet to such pipes as are in danger will usually ensure their protection.

Eighth. It is better to use a separate conductor for each set of pipes to be protected.

Ninth. Connection only at the power station, to water or gas pipes will not ensure their safety.

Tenth. Connection between the pipes and rail, or rail return wires, outside of the danger district, should be carefully avoided.

Eleventh. Frequent voltage measurements between pipes and earth should be obtained, and such changes in return conductors made, as the measurements indicate.

Mr. Farnham also says: "A system which many large roads are now adopting as a means of decreasing their current leakage is that of using insulated track feeders designed to carry the entire current, joined to the rails at short intervals, each 400 or 500 feet, for instance. The rails are thus employed as conductors only between the feeder junctions, and the liability of leaking currents is very much reduced. The system is certainly a step in advance of anything we have yet considered; and having been adopted in Boston, Brooklyn, Cleveland, etc., we should soon hear if by its use destruction of the pipes is wholly avoided."

An experiment will be tried in St. Louis, which is described by Mr. A. J. Reilley in a report to the board of public improvement, as follows: "It being desirable to make records of the electrolysis at various places along the water pipe system of the city that comparison may be made of the relative extent to which the electrolysis is going on during a definite time in various parts of the city, and, as this can not be done with any degree of accuracy with the instruments available for the purpose, without a great increase in the number of observers, the following method has been determined upon by the water commissioner and myself. A connection will be made with the water pipes at convenient stop valve and fire plug boxes with a small copper plate of known weight, and placed in the moist earth close to the water pipe and allowed to remain there for a definite time, its percentage of gain or loss in weight will be a measure of the current passing to or from the pipe through the plate and into the earth at that place. As a check, a similar test piece of copper, not connected to the pipe, will be buried close to the other in such a way that it will be subject to the same conditions from action of soil and moisture on the copper which may take place independent of the electric current from the water pipe. The proper corrections are to be applied on account of the action that may be set up between the iron and the copper independent of the earth return currents under consideration. I am led to believe that by continuing experiments of this kind and keeping proper record thereof, the affected territory can be definitely circumscribed. The determination of the direction of the street railway return currents must be by volt meter and ampere meter methods."

At the annual meeting of the Western Gas Association, a report of the committee on electrolysis, after investigations made, was summarized as follows:

First. Electrolysis from the grounded currents of electric roads is rapidly injuring gas and water pipes, and it is admitted by street railway people that the injury does proceed from their operations.

Second. Complete relief from its action *can not* be reached by any device applicable by those injured, but *is* attainable by certain changes in the electric railways.

Third. The gas and water interest should unite in demands for remedial measures which shall secure the adoption of systems undoubtedly effective, and which will thereby avoid a revival of the question a few years hence.

Fourth. Pending the discussion or completion of the relieving systems, the pipes should be protected at exposed points, at which the policy of increasing the resistance by insulation should be followed rather than that of increasing the conductivity by wiring.

Respectfully submitted,

GEO. T. THOMPSON,
ALTEN S. MILLER,
JAS. SOMERVILLE,
Committee.

The Water Board and Telephone Company, at Boston, have adopted, to some extent, a plan which consists of attaching copper conductors to the pipes at points of danger and leading the current back to its source at the power station. The New England Telephone and Telegraph Company has laid in Boston a special copper return wire along the affected part of the cable, and thence by a heavy overhead wire back to the power house. Of this plan an electrical expert of Boston says: "The larger and better distributed such a system of copper current from the water-pipes is the less danger from electrolysis; but the great outlay for copper involved is prohibitive beyond a certain limit. Whether within this limit the electrolysis can be reduced to such an important amount is by no means yet demonstrated. The data is still so incomplete as not to warrant a positive inference."

ROAD EXPERIMENTS IN OHIO.

The State of Ohio recently made, through its road commission, provision for a practical experiment of two propositions with regard to the public highways. Two bills have been passed, one permitting Geauga county to borrow $100,000 for the construction of steel tracks that can be used for wagons as well as by cars, and the other permitting the town of Canfield to issue bonds for $25,000 to construct a like road to Youngstown. The plan is urged by Martin Dodge, of Cleveland, who is president of the road commission. The theory of the commission is to experiment with this method with a view of adopting it in lieu of improving the roads by macadamizing.

ESSENTIAL QUALITIES OF PAVING BRICK.

Edward Orton, Jr., in an official report on the essential qualities of paving brick and the clays suitable for this purpose found in Ohio, says:

"The manufacture of clay paving material is a new industry in this state and country, and in the scale and manner in which the business is conducted, it is a new one to the world as well. Bricks have in the past been used to pave streets in a small way and in isolated cases for a long time, but the growth of the modern traffic in vitrified, imperishable materials, designed and guaranteed to bear the severest traffic for terms of years, is a new and valuable industry.

"The enormous bulk which the industry has attained in the last five years is wonderful, and the mental activity which has enabled a people to so quickly grasp the main principles, and with so few blunders carry a new industry forward to a permanent success, is another instance of the energy and intelligence of the nation and the state.

"What is really desired or needed to produce a perfect material is now beginning to be better understood, and as it is in the burning process where the qualities are largely made or lost, it is best to discuss the subject in this connection.

"The qualities which a city street must have to make it a good investment for the tax-payers who build it, are:

"1. Durability under heavy traffic. 2. Sufficient smoothness to make traction easy and comparatively noiseless, and yet not such smoothness as to make it slippery for horses' feet. 3. Reasonable cost. 4. Good sanitary qualities; that is, that the street as a whole, or the material of which it is composed, shall not be absorbent of the filth which always finds its way there, and thus become a receptacle for disease.

"Without entering into a general discussion, it is safe to say that vitrified clay is undoubtedly the most satisfactory material now in use in regard to the second, third and fourth specifications, and that the position of brick pavements yet remains to be proved in regard to the first point. Sufficient time has not elapsed since the laying of any street with what we now call good brick paving material, to enable us to make a deduction as to its relative wearing and cost compared with granite or other natural stone.

"The qualities, then, which must be possessed by bricks to fill the various requirements are:

"1. Vitrification, by which the material becomes indestructible by weather or any natural influence it will have to endure. 2. Toughness, which enables it to stand friction and blows without undue wear. 3. Uniformity, which prevents the early failure of the material in spots, which very soon extend, to the ruin of the whole.

"Vitrification is wholly a matter of burning. Toughness is a quality which depends on three conditions:

"1. The natural quality of the clays, some of which produce tough ware, and some of which do not. 2. The burning, which may be so managed as to destroy this quality wholly. 3. The cooling or annealing process, which, more than anything else, makes a brick tough or brittle. Uniformity is a quality effected by two forces:

"1. The process of manufacture, which ought to secure by its machinery material of very great homogeneity. 2. The burning, which can be managed so as to make but little variation in the different parts of one kiln, and also between the product of different kilns. So that on the burning, more than in anything else, the value of the material for paving purposes depends.

"The manufacture and sale of vitrified material for paving purposes is a new business, and one which is still in the early stages of evolution.

"Five years ago there was not a brick company in the State of Ohio which had any comprehension of the needs and necessities of the contractors, whom they so cheerfully agreed to furnish with vitrified brick. The manufacturers have been learning in the hard school of experience these five years.

"One of the great temptations of the manufacturer has been to grade his product leniently. Especially has this been true of all manufacturers who have been making paving blocks, or bricks of special shape and size, designed for street use only. To the maker of this class of wares, the merciless system of rejecting anything in anyway deficient has been almost an impossibility. It has meant in many cases a balance on the wrong side of the ledger at the end of the year. And above all the cheerful ignorance of those who have been inspecting and laying this material has made the moral strain on

the manufacturer still more severe.

"The advantages of paving blocks over brick are being recognized on all sides. In Ohio the Hallwood block was put into the market in 1888; now there are not less than ten different brands of blocks, all of which are essentially the same size, shape and weight, although manufactured by twenty different companies. The growth of the block manufacture would have been much more marked, except for one thing, that is, the disposition of the culls.

"In consequence of this fact, block makers have had an up-hill fight, and they deserve far greater credit than they receive, on account of what they have done to raise the standard of material.

"The future of this great industry largely depends on the concentrated efforts of paving brick makers to keep up the high grade of their wages. To sell a soft and imperfect article, or because the contractor who is putting the pavement down hopes to hoodwink the citizens who pay for the street by putting in an inferior material because he makes more out of it, is not only an act of dishonesty on the part of the contractor or manufacturer, but it is short-sighted policy as well."

SUIT AGAINST GARBAGE WORKS.

Dr. F. P. VanDenbergh, of the VanDenbergh Laboratory, Buffalo, has been retained by the Baynes Garbage Works in a suit brought in the Supreme Court to restrain the company from operating the garbage disposal works at East Buffalo. The Baynes Company utilizes about seventy tons of garbage a day, collected by the city of Buffalo.

These works employ a process by which the fat or oil is recovered and used in the manufacture of soap, while the residue, "tankage," is sold to fertilizer works. The complainants (property owners in the vicinity) claim that the operation of the plant is a menace to health and depreciates the value of property, and ask for large damages, besides an injunction closing the works.

Hon. Charles F. Tabor, ex-attorney-general of New York, has been retained with Dr. VanDenbergh to defend the company, and both maintain that the existing nuisance at East Buffalo is not caused by the Baynes Works, the evaporators, digestors and extractors being tightly sealed so that any of the vapors which might be expected to issue from the works are condensed and consumed.

There are several rendering works in the immediate vicinity which have a contract with the city of Buffalo as public scavengers where the rendering is done in open vats, and this is said to be the true source of the nuisance.

LOUISVILLE'S TEST OF PAVING BRICK.

The board of public works at Louisville, Ky., has devised a new test for the new vitrified brick streets in that city. The test, which was recently made, consisted in hauling over the streets a wagon weighted with seven tons of pig-iron and having the hind wheels locked. No apparent impression was made on the several varieties of brick which are laid in that city.

A DEMAND FOR CLEAN STREETS.

The Merchants' Association in San Francisco, while making a determined effort to have the system of street sweeping in that city changed and improved, is at the same time

trying to keep the streets and sidewalks clean by preventing the throwing of rubbish of any kind upon them. The association demands the strict enforcement of city ordinances against this, and in a printed circular appeals to business men to co-operate in the work.

PAVING BRICK IN IOWA.

B. Schreiner, city engineer of Des Moines, Iowa, says that the most convenient paving material for cities in Iowa is vitrified brick. "The raw material," he says, "is nearly everywhere present, good kilns are not expensive, and the clay working machineries of to-day are of high perfection and reasonably low cost, so that a plant can be installed with a moderate capital, proving a well paying investment."

BRICK PAVING IN DUNKIRK, N. Y.

Writing on the wear of brick pavements, the city engineer of Dunkirk, N. Y., says: "The brick pavement put down during the past year has proved satisfactory in every way, and the tax-payers are anxious for more of it. I consider brick for business streets in small cities far preferable to macadam. If properly put down on a concrete foundation six inches deep, it should last from fifteen to twenty years without much repairing. Of course, in time the corners will wear off as will those of the best blocks used. The cost of the brick pavement so far will average about $2.30 per square yard. The present year we propose putting down some on a broken stone foundation, which will reduce the cost to from $1.75 to $2.00 per square yard. I prefer a concrete foundation, but think if carefully put in and thoroughly rolled the ballast foundation will be all right, especially on streets where the travel is light. I would oppose anything but a concrete foundation for a business street, or a street with a heavy carting. The cost to property owners fronting on the street will average about $6.00 per frontage foot."

NORRISTOWN SEWERAGE SYSTEM.

The council at Norristown, Pa., has under consideration a proposition for the construction of a separate sewerage system for house and cesspool drainage exclusively which is about as follows: Vitrified clay pipe, the interior surface of which is of glassy smoothness, to facilitate the flow of the matter entering the sewer. At the dead ends of pipes will be located automatic flush tanks, which will completely flush the entire system every twelve hours. All sewage will be carried into a conduit constructed along the Schuylkill through the low-lying section of the borough limits, where it will discharge into the Schuylkill. With a view to the emptying of sewage into streams affording water supply being prohibited in the future, the conduit will terminate at a point where, when it becomes necessary, a reservoir may be constructed to receive the discharges from the sewer system. The deposits will be chemically treated at regular intervals, precipitating the solids which, after the liquid has been pumped off, will be removed and devoted to fertilizing purposes. It is estimated that about twenty miles of sewer will be required, at a cost of about 68 cents per lineal foot.

MEETING OF AMERICAN WATER-WORKS ASSOCIATION.

The fourteenth annual convention of the American Water-Works Association was held at Minneapolis, Minn., August 21, 22, 23 and

24. Addresses were delivered as follows: "Niagara Water Power," E. Geyelin, Philadelphia; "Water Supply and Fire Protection of the World's Columbian Exposition," William S. MacHarg, Chicago; "Filtration," J. B. Rider, New York City; "Damage for Appropriation of Streams," P. D. Wanner, Reading, Pa.; "Wells and Water Supply New Utricht, N. Y.," W. D. H. Washington, New York City; "Analysis of Public Water Supplies with Suggestions for a More Exact and Uniform System," Henry Leffmann, Philadelphia, Pa.; "The Prevention of Electrolysis of Water Mains and Service Pipes," Owen T. Smith, Freeport, Ill.; "Methods of Street Sprinkling and Cost," F. A. W. Davis, Indianapolis, Ind.; "Proposed Filtration and Purification of the Mississippi River Water and New Plan of Distribution for the City of Minneapolis," F. W. Cappelen, Minneapolis; "Experience with Fire Protection Lines," F. A. W. Davis, Indianapolis; "Private Water Companies, Province of Ontario," Willis Chipman, Toronto, Can.; "Electrolysis, Experiences and Opinions," A. A. Tucker, Memphis, Tenn.; "Socialism and Politics in Water-Works Practice," L. H. Gardner, New Orleans, La.; "Electrolysis Versus Water-Works Systems," C. Monjeau, Middletown, O.

LEGAL DECISIONS.

(Reported specially for PAVING AND MUNICIPAL ENGINEERING.)

Release of Sureties on Bridge-Contractor's Bond.—Sureties on a bond conditioned for the erection, in accordance with certain plans and specifications, and keeping in repair, of bridge abutments, are released from liability by a substantial change in the plans of the work, made by the principal and accepted by the obligee of the bond, without their knowledge or consent. Morgan County *v.* McRae, Sup. Ct. Kan., 36 Pac. Rep. 717.

Sufficiency of Contract for Sewer Construction.—A contract for the construction of a sewer is not void as failing to fix the time for the commencement of the work, when the superintendent of streets at the time it was executed, and with the knowledge of the contractor, wrote "the work to be commenced within fourteen days from the date of contract," at the end of the contract. Fletcher *v.* Prather, Sup. Ct. of Cal., 36 Pac. Rep. 659.

Option of Town to Buy Water Company's Plant.—Where a water company's charter gives the town the right to take the franchise and property on payment of the actual cost, the town's vote to take the plant completes the purchase, and its right to stop further extension of the plant accrues then, not when payment is actually made or tendered. Rockport Water Co. *v.* Rockport, Mass., 37 N. E. Rep. 168.

Assessment of Benefits for Public Improvements.—Under the statutes providing for the opening of streets, and assessment of benefits to property in the vicinity, the question whether property is in the "vicinity" and benefited is for the consideration of a jury; and it can not be said as a question of law that property upon a street, which has been widened so as to correspond with an extension, and situated on the extension two-thirds of a mile from the part widened, is not within the vicinity thereof, nor benefited thereby. Mock *v.* City of Muncie, App. Ct. of Ind., 37 N. E. Rep. 281.

Liability for Leaving Trench in Street.—One who digs a trench in a street and leaves it unguarded

is liable in a civil action for injuries resulting from neglect to perform this duty. Roe *v.* Crimmins (City Court of New York, General Term), 28 N. Y. Supp. 750.

Dedication of Land for Public Street.—Upon the recording of a plat of land where land appears upon the plat not numbered as a lot, but bounded by lines clearly intended to represent the line of a street, and lots are sold as being bounded on such street, such land is dedicated for a public street, though not named as such on the plat. City and County of San Francisco *v.* Burr (Supreme Court of Cal.), 36 Pac. Rep. 771.

Liability of Municipal Corporations for Defective Streets.—A village which has granted the right to construct a street railroad is chargeable with knowledge of what is being done under the grant, and therefore is liable for injuries caused by an excavation left at night without signal lights or guards, though the excavation was made on the day of the injury. Hoyer *v.* Village of North Tonawanda (Supreme Court, General Term, Fifth Department), 29 N. Y. Supp. 650.

Liability for Defective Sidewalks.—Under a charter providing that a lot owner shall not be liable for damages from failure to repair a sidewalk, unless he failed to repair it within ten days after notice is served on him, and after the common council shall order its repair, a notice given by the board of public works is insufficient, where the council had not ordered repairs. Under a city charter providing that if the lot owner neglects to repair a sidewalk as ordered, within the time prescribed by notice, and the city is compelled to pay damages on account of such neglect, the owner shall be liable to the city for the amount of damages so paid, the sole condition of the lot owner's liability is its establishment by a judgment against the city in favor of the injured party, and the right of action then is in the city alone. Lynch *v.* Hubbard (Supreme Court of Mich.), 57 N. W. Rep. 443.

Liability of Officers of Municipal Corporations.—The superintendent of streets of a city is liable for any damages resulting from his negligence in repairing a sewer, notwithstanding his official capacity. If the cost of making the repairs needed on the sewer exceeded $100 the superintendent of streets had no jurisdiction to do the work, and would be liable for damages unless he did it skillfully and diligently. Butler *v.* Ashworth (Supreme Court of California), 36 Pac. Rep. 922.

Liability for Changing Grade of Street.—Where a city council of a city changed the grade of a street (laid out before the railroad right of way was acquired) so that the street should cross over the railroad tracks, on a bridge with approaches, instead of crossing such tracks on a grade crossing, it was held that in such case the charters of the railroad companies do not impose upon such companies the obligation of paying the damages to owners of permanent buildings abutting on such approaches, caused by such change of grade, but that the statute creating liability for such damages imposes it upon the property benefited by such change of grade. Kelly *v.* City of Minneapolis (Supreme Court of Minnesota), 59 N. W. Rep. 304.

It is claimed that sewers of riveted steel pipe are more durable when covered with pure asphalt. For large sewers this pipe is cheaper than brick, lasts longer and will not cave in.

LETTERS FOR THE PUBLIC.

WICHITA YARD WATER CLOSET.

To the Editor of Paving and Municipal Engineering.

Herewith I send a rough sketch of what I call the "Wichita yard water closet," not knowing of their use elsewhere. There are a number of them in this city; one in my own back yard, which answers most satisfactorily, and the others are also reported to be working successfully.

In the construction a joint of tile sewer pipe of the main house drain near the alley line (our city sewers being in the alleys) is split lengthwise in halves, the upper part being removed; a brick box with sloping sides is built over the other part, as shown in the sketch, up to the floor of the outbuilding and well cemented on the inside, one side being left out in the sketch to show construction. Over this is a wooden box with a hinged seat, making it convenient as a urinal.

The house drainage will usually keep it clear, or a little extra flushing with water from the sink once a day will do this. Some turn the garden hose into the yard slop hopper for a few minutes if convenient. If thought necessary, in places, a small flush tank of one barrel capacity could be built to flush it, with the house sewage, but none are used here.

The longest diameter of the seat opening should be with the length of the split tile, and not across it, even when several seats are needed; these may be in different compartments of the same building, if desired. In such case, of course, more than one joint must be split. My own closet, an exceptionally shallow one, less than three feet to flow line below the surface, gave no trouble last winter, with a temperature of 14° below zero, nor have the others been bothered by frost. They have given general satisfaction and are the least costly or troublesome of any closet known.

O. Mulvey,
Late City Engineer.

A SUGGESTION TO PAVING BRICK MANUFACTURERS.

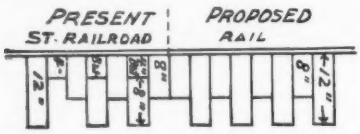
To the Editor of Paving and Municipal Engineering:

As the question of meeting rails in cities with brick paving has been brought up in our practice a number of times and no adequate method for strengthening the "brow" has been offered we would suggest the following points: The hardest wear on a street comes next the rails at the brow. With regular sized brick, to break joints, it requires a half brick alternately next the rail, which is a bad point. No necessity exists for brick shaped to match with a rail, because a wooden strip will fill a rail better and is more economical. With these points in view we would offer the following:

Let each manufacturer of paving brick make a number of brick double the length of his particular size and of the same dimensions otherwise. These can be made with any machine by changing the cut-off and without extra cost.

Such a brick will enable the engineer to have joints broken and at

the same time strengthen the brow at the rail, thus:



Make all *foundations stronger than the surface* in the same cross section. *Fremont Hill,*

Of Alexander, Hill & Enricht.

Chicago, Aug. 11, 1894.

DISPOSAL OF SEWAGE.

To the Editor of Paving and Municipal Engineering:

I am fully of the opinion that to meet the demands of coming sanitary requirements, all filth, or filth producing matter, must be kept out of drainage and foreseeing this requirement, have formulated plans for methods whereby the fecal products and garbage of a city can be gathered daily and taken out and be disposed of with no more offense to the senses than the delivering of food supplies. This is as it should be, and there are no practical reasons why it can not be done. The advantages of this system can hardly be estimated. It would add new industries, remove tons of rotting sewage under cities, and give unpolluted water supplies — besides lowering the death rate one-half. There is no fiction nor humbugging in this statement, because the methods are highly practicable. Of course, at sight, most, if not all, would declare the thing impossible to do—having in mind the handling and the common filthiness usual in connections, etc. To get at it, I reasoned in this way: That in the economy of nature, every thing has been created for a wise purpose, and in the revolutions of organic matter, each change must naturally be productive of economic results, and all in harmony—and since this is a law of nature it must be respected if good results are to be obtained—simply the following of true science, and a matter of art and skill to return to the soil, for nature's compensation, the grain and meat taken from the soil. It is the completion of the "round of art" in these things. If art can displace, it should be able to replace. If to replace appears to be difficult, to overcome the difficulty is what science teaches, and will not fail if the right lines are worked on. *Jas. M. Barker, C. E.*

Appleton, Wis., June 15.

SOLUTION OF MR. LOCKLING'S PROBLEM.

To the Editor of Paving and Municipal Engineering:

The problem presented by Mr. Lockling, if worked out from an assumed summit (1) or from a given gradient (2) is given by the formulæ below:

First.

$$D' = \frac{D\,a}{a+b}$$

Second.

$$D' = \frac{D\,R + (a-b)}{\frac{2\,R}{100}}$$

ft.

R = Rate per 100.

H. Ward.

Binghamton, N. Y., July 31, 1894.

FIVE WOODEN PAVEMENTS AT FREEPORT, ILL.

To the Editor of Paving and Municipal Engineering.

We have just finished macadamizing nearly one mile of streets and I would like to state that it is our opinion that leaving out some granite-topped boulevard in Chicago, we have the nicest, smoothest and most compact macadam yet made in the State of Illinois. It is so thoroughly compressed

and homogeneous as to the quality and size of the stone that there is no reason why it should not wear uniformly and with very little maintenance retain its smooth surface. It is equal to the best roads of France, next to asphalt in smoothness.

Probably the largest share of credit belongs to our mayor and city council who have voted the ordinance and specifications and given me their support during the construction. I wish also to add that my task was made easier by the willingness of our contractors, M. M. Frank McCann and John M. Kenety, of Dubuque, Iowa, who have spared no pains to make as perfect a job as practicable.

Arthur Lagron, City Eng.

Freeport, Ill., August 19, 1894.

SELECTIONS FROM THE PRESS.

THE VANDENBERGH LABORATORY.

In the scientific world the Vandenbergh Laboratory of Chemical Industry of Buffalo is one of the most potential. The best evidence of wide repute is the call which is made for the services of the members of this firm as experts and analysts. Their work is not confined to this State, but they have been engaged in some of the most important cases in the United States, in which either life or property have depended upon the testimony of scientists. Dr. F. P. Vandenbergh of this city founded the laboratory on a small scale in 1884 and as it supplied a want, success attended the enterprise. Such a demand was subsequently made for his chemical services that he founded the present Laboratory of Chemical Industry in 1892. The company is continually extending the scope of its work and it is proposed soon to erect a plant for the purpose of conducting their experiments in smelting and ore reduction. All of the proprietors of the Vandenbergh Laboratory are metallurgists and chemists of the highest standing. Their specialties are chemical technology, water supplies and mine inspection. Prof. F. P. Vandenbergh, Prof. R. A. Witthaus, Dr. Isaac Kemoe, Mr. A. P. Vandenbergh and Mr. Paul Escher, who compose the company, are all chemists and chemical engineers of the highest standing in scientific circles and their extensive and practical experience as well as their successful careers, enables them to be classed among the best of scientists. Dr. Vandenbergh was the popular and highly esteemed professor of chemistry in the university of Buffalo for six years and also held the responsible position of city chemist for a term of seven years. He is the author of "Vandenbergh's Laboratory Guide," a most helpful volume with 200 valuable experiments. Dr. Vandenbergh has served as an expert in many litigations of importance and has attained national reputation.—*Buffalo Times.*

SURFACE DRESSING OF BRICK PAVEMENTS.

Close observation of brick paving in this city since it began convinces us that the most valuable surface dressing, after the brick are laid, is one liberal dressing of cement immediately followed by a

sand dressing pressed into the cement. The cement at the bottom of the spaces is useful in preventing water from saturating the sand cushion, but it is useless at the top. This treatment is suggested by the fact that the best filled spaces between the brick are everywhere found where there was a deposit of sand on the first dressing, the sand being required in mixing the cement.

Put on one liberal dressing of cement and add the sand at once, which should be rolled with the roller used in surfacing the brick. After a few days the surplus sand can be removed, and you will then have a clean and satisfactory street, if you refrain from washing out the filling between the brick and do not rake it out with the street cleaning machine.—*Lockport (N. Y.) Union.*

MACHINERY AND TRADE.

NEW YORK'S NEW STREET-SWEEPING MACHINE.

A new system of street-sweeping is being tried in New York city by Street-Cleaning Commissioner Andrews. The new sweeper is a diminutive copy of the big horse sweeper, and has three wheels instead of two. It is worked by one man like a push-cart, and the experiments made indicate that it will be a success on a smooth asphaltic surface, but it is not so thorough or satisfactory on granite blocks, and it is said that the work of propelling the machine on a granite pavement is too hard to suit the ordinary street laborer. It is proposed, if the machine is perfected so that it will sweep properly, to apply an attachment that will pick up the dirt as the machine moves along, and when this receptacle for sweepings is full it is to be removed and loaded on a truck. The sweepings can then be removed to the dumping scow without liability of being scattered.

ENLARGEMENT OF THE GATES IRON WORKS.

The Gates Iron Works has leased a track of land having a frontage of 180 feet on Hawthorne ave., facing Willow street, and running 450 feet to the north branch of the Chicago river. The lease will run for fifty years, and on this property will be erected an extensive brick and steel machine shop covering the entire leasehold. In addition, the company has secured a lease on the property across Hawthorne ave., having a frontage of 250 feet on Hawthorne ave., and running through to Marcy street, and having a frontage of 150 feet on Marcy. The company has purchased the improvements on this property, which will be entirely remodeled and refitted to suit its growing needs. On Hawthorne ave. are tracks of the Chicago, Milwaukee & St. Paul R. R., from which a switch runs into the recently-leased property of the Gates Iron Works. On the other side are docks, where machinery may be loaded directly to the decks of vessels. Thus the company will have unsurpassed facilities for rapid transportation. This newly-leased property gives the company the most extensive plant in its line in the West, and with the extensive remodeling and improved machinery and appliances that will be added, its facilities for turning out mining ma-

chinery of all kinds will be unsurpassed by those of any rival establishment in the country. This enlargement of capacity and facilities has been contemplated for some time, as the rapid and enormous growth of the business rendered the plant now occupied utterly inadequate to properly handle the company's enormous business.

NOTES.

Taplin, Rice & Co., of Akron, O., have been very busy during the last year.

Wooster, O., has a new industry in the Shale Brick Co., which recently began operations there.

The Wrought Iron Bridge Company, of Canton, Ohio, are running their shops eleven hours a day.

The Advance Fire Clay Co. at Uhrichsville, O., has been incorporated with a capital stock of $15,000.

A. Ebersole, of the E. M. Freese Co., of Galion, O., contemplates establishing a brick and tile plant at Perry, Ia.

A new and extensive brick plant has been erected at Canton, Ohio, by the Cleveland Brick Company. The plant has four kilns.

The F. C. Austin Manufacturing Co., of Chicago, made sales during August of street-sweepers at Oskaloosa and Burlington, Ia.

The Wrought Iron Bridge Co., of Canton, O., secured the contract for the buildings of the new tinplate mill at Cambridge, O.

The Stanberry Press Brick Co. has been incorporated at Stanberry, Mo., by D. F. Hill, Frank Jones, J. D. Halstead, J. J. Egart and Louis Valin. Capital stock, $20,000.

The Warren-Scharf Asphalt Paving Co. has erected a plant at Muncie, Ind. The factory is a substantial building of brick and wood.

Messrs. W. P. Blair and Joseph Ayers, of Brazil, Ind., contemplate locating a large brick and sewer tile plant just west of Terre Haute, Ind.

The Salt Lake Pressed Brick Co., of Salt Lake City, Utah, will burn paving brick in their new downdraft kiln which was recently erected.

A total of fourteen tons of asphaltum have been shipped to Chicago from the new asphaltum mines near Rangely, Colo., by Mr. St. V. LeSieur.

Reichert & Co., of Racine, Wis., and Carl H. Wells, of Appleton, have leased the foundry of the Appleton Manufacturing Company, at Appleton, and will manufacture sewer and culvert pipe.

The Nay-Aug Shale Brick Co., Scranton, Pa., has been granted a charter; capital stock, $65,000. Directors—W. A. Connell, W. W. VanDyke, S. W. Roberts, Hanson Carpenter and Horace E. Hand.

A syndicate of Columbus (O.) capitalists has bought about 780 acres of land near Salina, six miles north of Athens, and will erect an immense plant for the manufacture of paving and building brick, and sewer pipe and tiling.

The brick manufacturers of Pennsylvania and Eastern Ohio held a meeting for the purpose of organization, at Rochester, Pa., August 16th, and a committee of five was appointed on organization. Another meeting will be held at Cleveland, September 11th, when an election of officers will take place.

The old Pennsylvania farm at Perkiomen Junction, Pa., has been purchased by Thomas B. McAvoy, a prominent brick manufacturer of Philadelphia, who, with several other capitalists, will erect a mammoth vitrified paving brick plant.

The Dumesnil Brothers' Co. has purchased the entire plant of the Hydraulic Pressed Brick Co., located at Jackson and Burnett aves., Louisville, Ky. The purchasers will take immediate possession, and will improve the plant.

A delegation from Manchester, Mass., recently visited Lowell for the purpose of viewing the Carson Trench Co.'s sewer machine which has been purchased by that city. The street commissioners of Manchester contemplate the purchase of one.

A company has been formed at Anaheim, Cal., with D. S. Redican, of Los Angeles, as manager, for the purpose of manufacturing asphalt cement from the asphaltum, which is found in great quantities in the hills back of Anaheim. It is said to be superior in many respects to gravel cement and can be produced 40 per cent. cheaper.

The Columbian Brick Company has been incorporated at Syracuse, N. Y., to manufacture and sell paving and building brick and other articles. The incorporators are Amos L. Mason, Wm. J. Gillette, Duncan W. Peck, Syracuse; Edmund Reed, Marcellus, N. Y.; John F. Gaynor, Fayetteville, N. Y.

The Chambers Brothers Co., of Philadelphia, have made recent sales as follows: New paving brick plant to T. B. McAvoy & Sons, at Philadelphia; complete plant to J. Ryttenberg & Sons, at Sumter, S. C.; brick machine and pug-mill to parties in Jacksonville, Fla. They also have in course of construction a complete equipment for works near Savannah, Ga.

The Purington Paving Brick Co., of Galesburg, Ill., is putting down in Chicago, free of cost, a vitrified brick pavement on the east side of LaSalle street, between Washington and Madison streets. J. H. Flagg, engineer of the street department, thinks that repressed brick only are suitable for paving purposes, and the Purington company takes this method of demonstrating to the city the superiority of vitrified paving brick.

IMPROVEMENT AND CONTRACTING NEWS

PAVING.

Main street at Hockanum, Conn., has been newly macadamized.

Fifth and Santa Fe streets, Kansas City, Mo., have been completed and accepted.

A committee of the council of Pittston, Pa., is investigating street paving in sundry cities.

Syracuse, N. Y., has nearly a million dollars' worth of paving contracts not completed.

The brick paving on Illinois avenue, at Peoria, Ill., is under course of construction, and will be rapidly pushed to completion.

O. R. Rauchfuss, city engineer at Joliet, Ill., writes that the city council appropriated $58,000 for permanent improvements August 6.

Henry Kelling, city clerk at Walla Walla, Wash., writes that the expenditures of Walla Walla county for roads and bridges during the year ending June 30, 1894, was $13,525.68.

E. H. Keating, city engineer at Toronto, Can., has recommended that paving contractors be relieved from putting in scoria toothing, as it is found to hardly be worth the inconvenience caused by putting it in.

The bids received for asphaltic paving on Washington avenue, Detroit, Mich., were nearly one-half the price less than they formerly were. The rate for paving, aside from curbing and excavation, was $1.75, while formerly it was $2.90, and more.

The bids received recently for paving Greenup and Scott streets, Covington, Ky., with brick, were rejected, and the city engineer instructed to prepare new specifications containing a clause in which contractors are required to give bond guaranteeing the street for a period of not less than five years, and that 10 per cent. of the contract price be retained for that period of time.

Chas. L. Proda, city engineer at Santa Cruz, Cal., writes that Laurel street has been macadamized with limestone, at 60 cents per square yard; Pacific avenue has also been repaved with bituminous sandstone. The surface of the old street was broken up and shaped by adding crushed limestone, and rolled, the covering of limestone being ten inches thick after being rolled. Cost, 54 cents per square yard.

CONTEMPLATED WORK.

South street will be paved at Utica, N. Y.

Sullivan, Ill., contemplates some street paving.

Water street will be paved with brick at Sandusky, O.

Claremont street, Cleveland, Ohio, will be paved with brick.

Bowers street will be paved with asphalt at Jersey City, N. J.

Broadway will probably be paved with brick this year, at Cleveland, Ohio.

Four blocks of street paving will be done at Astoria, Illinois, next year.

Plans have been prepared for paving Main and Water streets at Pittston, Pa.

A vitrified brick pavement is contemplated for Fourth street, at Logansport, Ind.

It is thought that the north esplanade at Leavenworth, Kas., will be paved with brick.

A brick pavement has been recommended for Third and Birch streets at Bethlehem, Pa.

The council at Hammond, Indiana, contemplates the macadamizing of Calumet avenue.

A sheet asphalt pavement will be constructed on Summit avenue, at Schenectady, N. Y.

Legislation has been made at Aurora, Ill., for the paving of View street and West Park avenue.

Franklin avenue, from Spruce to Linden street, Scranton, Pa., will be paved with vitrfied brick.

Fayette street, between Calvert and Liberty streets, Baltimore, Md., will be paved at an early date.

Milwaukee capitalists are planning for the extension of the Sheridan road from Waukegan to Milwaukee.

Nicollet avenue, at Minneapolis, Minn., will be paved with vitrified brick, and Hennepin avenue with asphalt.

An ordinance has been passed at Greensburg, Pa., authorizing the paving of Talbott avenue with vitrified brick.

The street committee at Chester, Pa., has resolved to macadamize East Eighth street, and possibly Tenth street.

A petition has been circulated at Altoona, Pa., asking that West Chestnut avenue be paved with vitrified brick.

The board of trustees at Avery, Ill., has appropriated $8,000 for a brick pavement on the Galena road, to be constructed next year.

The street committee at Wilkes-Barre, Pa., are considering a vitrified brick pavement for City alley and for Merchants' alley.

The residents of East College street, Middletown, Conn., ask that the macadamizing done on that street last year be extended.

Pittsburg, Pa., has in contemplation two magnificent boulevards, which, if constructed, will give the city many miles of drive-ways.

Ordinances have been passed at Cincinnati, Ohio, for paving Evans street and Bush alley with brick, and Court street with asphalt.

Property owners on Hay alley, at Cincinnati, O., have petitioned the council to pave it with brick, and change the name to Hay avenue.

Property owners on Massschusetts avenue, Cincinnati, have petitioned for a brick pavement, and on Hobson street for a brick or macadam pavement.

The Peachtree road at Atlanta, Georgia, will be paved with chert or macadam, from Bleckey avenue to Wilson avenue, and on to the exposition grounds.

The street committee at Wilkes Barre, Pa., has been instructed to advertise for bids for paving, with vitrified brick, Water and North streets and Courtright avenue.

Petitions have been made by the property-owners on Grand avenue and Sixteenth street, at Davenport, Ia., asking that these thoroughfares be paved this year.

The asphaltic pavement, for which an ordinance has been passed at Peoria, Illinois, will give that city a continuous asphaltic drive, extending from one end of the city to the other end.

Ordinances have been passed at Toledo, O., providing for the paving of Tecumseh, Sixteenth and Fourteenth streets with Trinidad asphalt, vitrified brick, cedar blocks or Hallwood blocks.

Petitions were recently made at Dayton, Ohio, for street asphalt pavements in sundry streets. Germantown, Gurley and Jersey streets will also be improved by graveling the roadways.

The property owners on Butternut street, at Syracuse, N. Y., want the street paved with brick. A petition has been circulated for an asphaltic pavement on Adams street, from Warren street, east, also.

Contemplated work at Kansas City, Mo., is as follows: A mile of asphaltic paving on Fourteenth street; paving McGee street with brick; Thirteenth street, vitrified brick; Locust street, asphalt; Garfield avenue, asphalt; Park avenue, macadam; Lydia avenue, macadam.

The property owners on East Washington street, Indianapolis, Ind., have petitioned for an asphaltic pavement from Noble street to Rural street. A petition has also been filed asking that the west sidewalk of Broadway, from Eleventh to Twelfth street, be paved with cement.

CONTRACTS TO BE LET.

Bids are invited until September 10, at South Bend, Ind., for cement paving and curbing.

Bids are invited at Cleveland, O., until September 12, for paving Denison avenue with brick.

Bids will be received at Cincinnati, O., until September 15, for paving Court street with asphalt.

Bids will be considered at Jacksonville, Fla., September 6, for paving certain streets with stone.

Bids are invited at Elkhart, Ind., until September 5, for constructing cement sidewalks on Jackson street.

Sealed proposals are invited until September 10, at Lafayette, Ind., for the improvement of sundry streets.

The board of public works at Ft. Wayne, Ind., invites bids until September 3, for constructing brick sidewalks.

Sealed proposals will be received at Springfield, O., until September 10, for laying cement and brick sidewalks.

Bids will soon be invited for paving two streets at Appleton, Wis., with cobblestones and two with cedar blocks.

Sealed proposals will be received until September 4, at Washington, D. C., for laying sheet asphalt and asphalt block pavements.

Sealed proposals are invited until September 3 at St. Paul, Minn., for paving with asphalt, Sibley, Fourth and Seventh streets.

Bids will be received at Jacksonville, Fla., until September 6, for furnishing 75,000 square yards of vitrified paving brick material.

Bids are invited at Charleston, Ill., until September 24, for paving with brick, Columbus, Jackson, Washington and Lafayette streets.

Bids are invited at Madisonville, O., until September 4, for constructing cement sidewalks in Charles, Centre, Poplar and Walberg streets.

Sealed proposals will be received at Cincinnati, until September 6, for paving John street with asphalt. Bids will also be received, until September 8, for paving Vine street with asphalt.

Sealed proposals will be received at Charles City, Ia., until September 3, for paving Main street with brick from Cedar river to Blunt street, and for macadamizing Main street from Blunt to Hulin street.

Bids will be received until September 15, for about one mile of asphaltic paving on four-inch concrete foundation, with curb and gutter, in Woodruff Place, Indianapolis, Ind. Chauncey Butler or Dr. J. R. Hussey should be addressed.

CONTRACTS AWARDED.

Ricker, Lee & Co. secured the contract for paving a number of streets at Galveston, Tex.

The contract for paving Larimer street, paving district No. 2, Denver, Colo., was awarded to F. O. Blake & Co.

The council at Bellevue, O., awarded the contract for paving S. West street to R. Richardson, of Port Clinton, O.

The contract for paving W. Main street, at Ionia, Mich., was awarded to James Hurley, of Bay City, for $4,476.99.

The contract for paving Main street, at Salamanca, N. Y., was awarded to Shea & McGhann, of Bradford, for $7,700.

The contract for macadamizing Elland avenue, at Cincinnati, Ohio, was awarded to P. Gleason & Son, for $11,253.50.

The contract for paving Quail street with vitrified brick, at Albany, N. Y., was awarded to Robert H. Strong for $6,141.42.

Costello & Neagle, of Elmira, N. Y., were awarded the contract for 1,772 square yards of brick paving at Oswego, at $2.09 per yard.

The Fruin-Bambrick Construction Co., of St. Louis, was awarded the contract for paving Perry street with asphalt, at Peoria, Ill.

Eugene Kirk writes that the Barber Asphalt Co. was awarded the contract for paving East Federal street, at Youngstown, O.

The contract for paving the carriageway of State street, at Schenectady, N. Y., was awarded to Robert H. Strong, of Albany, for $15,111.41.

The contract for paving Fourth avenue, at Atchison, Kan., has been awarded to John Gaffney, of the Atchison Vitrified Brick Company.

The Kramer-Irwin Rock, Asphalt and Cement Co., of Hamilton, Ont., was awarded the large asphaltic street paving contract in that city.

The contract for paving South West street, Bellevue, O., was awarded to R. Richardson, of Port Clinton. Massillon brick will be used.

The contract for paving Pearl street, from Missouri to Helen street, Indianapols, Ind., was awarded to the Indiana Paving Brick Co., at $2.60 per lineal foot.

The contract for paving Center and Main streets, at Marion, O., was awarded to Coleman & Hallwood, of Columbus, at $1.59 per foot for Center, and $1.61 for Main street.

The Flint Brick Co., of Des Moines, Ia., secured the contract for paving High street with two courses of brick on a sand foundation, with asphalt cement top filling, at Marshalltown, Ia.

The Rockford Construction Co. was awarded the contract for street paving at Streator, Ill., at prices ranging from $1.18 to $1.23 per square yard, the lowest prices ever paid in that city before.

H. Ward, Binghamton, N. Y., writes that the Warren-Scharf Asphalt Company was awarded the contract for paving part of Court, Henry and Chenango streets with asphalt on a concrete foundation, at $2.75 per square yard.

Contracts have been awarded at Dayton, Ohio, as follows: Fifth street, from Wilkinson to the river bridge, asphalt, Warren-Scharf Asphalt Company; Fifth street, from Ludlow to Wilkinson, asphalt, Trinidad Asphalt Company.

The contract for paving Eleventh and Fifth streets, and Forest avenue, at Kansas City, Mo., was awarded to the Barber Asphalt Paving Co. J. E. Farris secured the contract for paving Santa Fe street with brick, at $1.54 per yard.

The contract for paving Dexter avenue, at Montgomery, Ala., was awarded to John W. Sibley, of the Coaldale Brick and Tile Company, of Birmingham, Ala. The pavement will be laid on a six-inch hydraulic cement concrete foundation made of broken stone.

Contracts were awarded, at Philadelphia, Pa., for about $150,000 worth of paving. The contracts were divided between the Vulcanite Paving Co., the Philadelphia Asphalt Paving Co., the California Petroleum and Asphalt Co., the Inter-state Vitrified Brick Co., the Mack Paving Co. and others.

Recent contracts were awarded at Detroit, Mich., as follows: Washington avenue, brick, Lennane Bros., $10,511.12; Holden avenue, cedar blocks, Patrick Dee, $6,709.56; Fifteenth street, from Michigan avenue to the bridge, $6,980.82, and from the bridge to Fort street, $9,272.66, Patrick Dee; Tenth street, Talbot Paving Co., $3,897.40; Holden avenue, Smith & Reynold, $3,519.58.

The contract for the McCaul street pavement, including street track allowance, at Toronto, Can., was awarded to the Warren-Scharf Co., as follows: Scoria blocks, $3.25 per square yard; gravel under ties and concrete, $1.15 per cubic yard; concrete, to include everything, $5.20 per cubic yard; 2½-inch asphalt surface, without concrete base, $1.48 per square yard. Other contracts awarded to the Warren-Scharf Co. were: Cecil street, $9,657; Wellesley street, $11,835.

Syracuse, N. Y., has let contracts to pave the following streets with Trinidad sheet asphalt: To the Syaracuse Improvement Company, Walnut avenue and Walnut place, 14,170 square yards, for $47,694.50; West Genesee street, 17,930 square yards, for $68,433; Lock street, 2,760 square yards, for $8,773.75; Slocum avenue, 3,210 square yards, for $14,798; to the Warren-Scharf Asphalt Paving Company, Montgomery street, 3,200 square yards, for $12,880. Also, the following for vitrified brick, to Homer & Co., of Olean, N. Y.: West Genesee street, 26,200 square yards, for $88,673.75; Leavenworth avenue, 2,950 square yards, for $8,556; Plum street, 2,760 square yards, for $7,842.

SEWERS.

A new 15-inch pipe sewer, 180 feet in length and 16 feet deep, is being laid at Lowell, Mass.

The Fourteenth street sewer has been completed at Indianapolis, Ind., at a cost of $201,104.86.

The big east side sewer, work on which will soon begin at Des Moines, Ia., will be 11,000 feet long.

The city of Los Angeles, Cal., has just completed an irrigation sewer 15 miles long, and extending to the ocean.

One mile of brick sewers and two miles of pipe sewers have been constructed at North Tonawanda, N. Y., at a cost of $60,000.

The Thomas creek overflow outlet sewer, which has been under course of construction for about seven months, at Rochester, N. Y., is completed.

CONTEMPLATED WORK.

A sewerage system is contemplated at Prescott, Ont.

A sewerage system is being agitated at Olneyville, R. I.

A sewer is contemplated on Peach street, at Erie, Pa.

Fulton, N. Y., contemplates the construction of sewers.

Everett, Wash., will issue bonds for the construction of sewers.

Plans have been prepared for the North Tarrytown sewer system.

A sewer is recommended for Fifteenth street, at Milwaukee, Wis.

A system of sewerage is being urged at Gastown, Tonawanda, N. Y.

A sewerage system is contemplated for the village of Cazenovia, N. Y.

New sewers will be constructed in Bridge and Russell streets at Manchester, N. H.

Sacramento, Cal., has under consideration six new plans for the proposed sewer system.

The sewerage system of Savannah, Ga., is inadequate, and an improvement is being urged.

An ordinance has been passed providing for a sewer in Livingston street, at Elizabeth, N. J.

A resolution has been adopted at York, Pa., providing for a 48-inch sewer in Princess street.

The construction of a sewer in Sixth street, at Lafayette, Ind., is declared necessary by the council.

The sewer committee, at New Britain, Conn., has recommend the construction of a sewer in Cherry street.

The Windsor city council, Detroit, Mich., has decided to use 10,000 of the sinking fund for sewer construction.

A 56-inch main sewer has been recommended at Minneapolis, Minn., on Fourteenth avenue and Lake street.

Ordinances have been passed at Chester, Pa., authorizing the construction of sewers in Fourteenth and Fifth streets.

Ordinances have been introduced in the city council at Atlanta, Ga., for the construction of sewers in sundry streets.

The extension of a tunnel trunk sewer and the construction of a new trunk sewer is contemplated at Niagara Falls, N. Y.

The committee on sewers, at New Haven, Conn., has recommended the construction of sewers in a number of streets.

An ordinance is pending at Newark, N. J., providing for the construction of twelve and one-third miles of sewers at a cost of $65,000.

The sewerage question is again being agitated at Madison, Wis. A new system, at an expenditure of $71,500, has been recommended.

An ordinance has been passed at Towanda, Pa., authorizing the construction of sewers in Main, Walnut, Cherry, and Elizabeth streets.

The council at Council Bluffs, Ia., contemplates the construction of a big sewer in Indian creek, from Bryant street to a point west of Mynstor.

The citizens of Vicksburg, Miss., favor constructing a sewerage system, and if unable to complete it, build it as far as the $100,000 in bonds will permit.

E. P. Clandon, San Antonio, Tex., writes that the city tax-payers have voted in favor of sewers. Bonds to the amount of $500,000 will be issued at once.

Sewers will be built at Syracuse, N. Y., as follows: 15-inch tile sewer in McBride, South Salina, Madison, and Lock streets; a 12-inch sewer in Slocum avenue.

An ordinance has been passed at Newark, N. J., providing for the construction of sewers in May street and Wakeman and Summer avenues. A sewer is also contemplated in Prospect street.

The board of public works at Oconto, Wis., contemplates the construction of a sewerage system. The topography of Oconto makes it difficult to devise a system that will prove beneficial to all the wards.

Sewers will be built at Chester, Pa., as follows: Third street, from Tilghman to Broomall streets; Edgemont avenue, from Fourteenth to Fifteenth streets; Edgemont avenue, from Ninth to Eleventh streets.

Some plan is to be devised at St. Louis, Mo., for preventing contamination of the River des Peres, which is used as an open sewer to carry off sewage from Forest Park and Cabanna place. Chemical precipitation has been advised.

CONTRACTS TO BE LET.

Bids are invited until September 5, at Elkhart, Ind., for the construction of a sewer.

Bids are invited until September 3, at Omaha, Neb., for constructing two brick culverts.

Bids will be received at Flushing, N. Y., until September 4, for building a sewer in State street.

Bids are invited at Chicago, Ill., until September 4, for laying private drains in sundry streets.

Bids will be received at Fostoria, Ohio, until September 17, for constructing about 7,749 feet of sewers.

Bids are invited until September 10, at South Bend, Ind., for constructing a pipe sewer in Michigan avenue.

Sealed proposals will be received at St. Paul, Minn., until September 3, for building a sewer in Stryker avenue.

Bids will be received at Fort Wayne, Ind., until September 3, for constructing a fifteen-inch vitrified clay-pipe sewer.

Sealed proposals will be received at Ligonier, Ind., until September 13, for the construction of a sewer in First street.

Wm. A. Johnston, Barberton, O., writes that bids will be received until September 29, for the construction of main sewers.

Sealed proposals will be received at South Bend, Ind., until September 10, for constructing a pipe-sewer in Michigan avenue.

Bids are invited at Keokuk, Ia., until September 3, for constructing about 155 lineal feet of six-foot brick sewer in alley, block 195.

Bids are invited until September 3, at Montgomery, Ala., for building 11,899 lineal feet of brick sewerage and laying 7,274 lineal feet of terra cotta pipe connection.

Sealed proposals will be received until September 3, at Montgomery, Ala., for building 11,899 lineal feet of brick sewerage and 7,274 lineal feet of terra cotta connections.

O. R. Rauchfurs, Joliet, Ill., writes that bids will be received until September 3 for the completion of sewers as follows: Elwood street, 2,600 ft.; Spring street, 2,200 ft.; Exchange street, 1,400 ft.; Columbia street, 2,000 ft.; McDonough street, 1,000 ft.; McDonough street, 1,200 ft.; Ross street, 3,000 ft.; covering slough drain, 3,000 ft.

CONTRACTS AWARDED.

The contract for constructing a sewer at Monroe, Wis., was awarded to N. F. Reichert, of Racine.

Bartow & Clement, of Dayton, O., secured the contract for the Ross avenue sewer at Hamilton, O.

The contract for the sewer outlet at Valparaiso, Ind., was awarded to the St. Joe Paving and Sewer Co., of South Bend.

Contracts for sewers were awarded at Davenport, Ia., as follows: Third and Marquette streets, Daniel Keleher; Farnam street, Patrick Connelly.

The contract for the Meigs-street sewer at Sandusky, O., was awarded to John McKean for $4,577.11, and the Madison-street sewer to Patrick Martin for $6,682.49.

Thomas A. Nevins was awarded the contract for building the East Orange sewer outlet for $230,000. He also signed an agreement to connect it with the one to be built by Newark without extra charge.

H. Ward, Binghamton, N. Y., writes that sewer contracts have been awarded as follows: A pipe sewer on North street, J. C. Smith, $310; pipe sewer on Oak street, W. A. Conklin, $1,389; pipe sewer on Vincent street, E. A. Matthews, $892.

The contract for building the Park Place district sewer at Pittsburg, Pa., was awarded to George F. Egan, for $18,010.84. The sewer will be two and a half miles long. The bid is thought to be the lowest ever made on a contract of similar magnitude.

Contracts for sewers have been awarded in Syracuse, N. Y., as follows: 850 lin. ft. of 18-inch tile, and 780 lin. ft. of 15-inch tile sewer, in W. Genesee street, to L. D. Hulbert, for $1,898: 650 lin. ft. of 18-inch tile sewer in Oneida street, for $896, and 130 lin. ft. 12-inch tile sewer, in Grace street, for $157, to Frank Street; 240 lin. ft. 12-inch tile sewer, in London avenue, to H. W. Jones, for $157; 400 lin. ft. 15-inch tile sewer, in Madison street, to H. W. Jones, for $512; 560 lin. ft. 15-inch tile sewer, in S. Salina street, to James Swift, for $532; 730 lin. ft. 15-inch tile sewer, in McBride street, to William Lewis, for $547.50.

WATER-WORKS.

The water-works system at Grinnell, Ia., is completed.

The new water plant at Morgan Park, Ill., which is now in operation, gives good satisfaction.

The New Orleans Water Company, at New Orleans, La., declares that it is impossible to filter the Mississippi river water at that point, and it is possible that New Orleans will have to get its supply from another source.

The water-works supplying the principal cities and towns of the United States represent an investment of $430,000,000, according to the *Wall Street News*. The total number of cities and towns in the whole country supplied with water-works is about 1,700. About two-thirds of all the works belong to the municipalities, the balance being private enterprises.

The new aeration and filtration system at Mount Vernon, N. Y., is in operation. By means of a cast-iron pipe-line the water is conducted from a large reservoir above New Rochelle, a distance of three miles. It runs over the natural rocky ledges for a distance of over 100 feet, which exposes the water to the action of the atmosphere, thereby oxidizing the chlorine of ammonia if any exists. It is then permitted to run into the filtering basins, of which there are three, and is then distributed through the city.

CONTEMPLATED WORK.

A new water supply is needed at Olean, N. Y.

A system of water-works is needed at Montezuma, Ia.

A system of water-works is being agitated at Converse, Ind.

Mt. Vernon, Ia., is again agitating the question of water-works.

Plans have been prepared for a water-works system at Alton, Ia.

Pineville, Ky., contemplates the purchase of the water-works at that place.

Creswell, Mich., voted to bond the village for $9,000 for a water-works system.

A system of new water-works and an adequate supply of water is being agitated at Paris, Mo.

The city council at New Albany, Ind., is considering the purchase of the water-works system.

The board of managers of the Soldiers' Home, at Greenville, Mich., is considering a suitable water supply for the home.

An investigation of the water supply at La Crosse, Wis., was recently made to formulate plans for a new system, or an addition to the old one.

The water-works committee at Sacramento, Cal., has been instructed to correspond with manufacturers of machinery and filter companies.

Water-works are being agitated at the following places: Celina, O.; Leavenworth, Ind.; Calhoun, Ky.; Corydon, Ia.; Jasper, Ind.; Spencer, Ind.; Dunellen, N. J.; Rhodes, Ia.; Sebewaing, Mich.; Long Prairie, Minn.; Rockville, Ind.; Warren, Ill.; Toulon, Ill.; Sigourney, Ia.; Elizabeth, Pa.; Lodi, Wis.; Crowley, La.

The construction of water-works is contemplated at the following places: Vernon, Ind.; Glencoe, Minn.; South Glenn Falls, N. Y.; Abingdon, Ill.; Richwood, N. J.; Taneytown, Md.; Lancaster, Ill.; Good Hope, Ill.: Albany, Ind.; Liberty, Ind.; Lodi, Wis.; Oelwein, Ia.; Perrysville, O.; Galena, Ill.; La Harpe, Ill.; Le Roy, N. Y.; Morrisville, N. Y.; Elmwood, Ill.; Stuart, Ia.; Eaton Rapids, Mich.; Trenton, Mich.; Salem, Mass.; West Hampton, Mass.; Prescott, Ont.

CONTRACTS TO BE LET.

Bids are invited at Woodstock, Ill., until September 7 for the construction of water-works.

Sealed proposals will be received at Portland, Ind., until September 4, for a system of water-works.

Bids are invited at DeKalb, Ill., until September 4, for the construction of a water-works system.

Sealed bids will be received at Syracuse, Neb., until September 6, for the construction of water-works.

Bids will be received until September 5, at Peru, Ind., for laying 560 feet of 6-inch water pipe in Canal street.

Bids are invited until September 3 at Aberdeen, S. D., for laying a 4-inch cast-iron water main, with gates, valves and connections.

O. R. Rauchfurs, Joliet, Ill., writes that bids are invited until September 3, for 500 tons of 14-inch cast-iron water pipe; 35 tons of 12-inch water pipe, and 9,500 lin. ft. of excavation and back filling.

CONTRACTS AWARDED.

The U. S. Windmill Co., of Batavia, Ill., was awarded the contract for putting in water-works at Fullerton, Neb.

The contract for the erection of water-works at Rankin, Pa., was awarded to John P. McIntire, of McKeesport, for $16,805.42.

The contract for constructing the water-works at Northfield, Minn., was awarded to Million & Young, of St. Paul, for $32,540.

The contract for laying eight miles of water pipes at Syracuse, N. Y., was awarded to Fales & O'Donnell of Tonawanda, for $13,176.

The contract for building the water-works at St. Bernard, O., was awarded to the Laidlaw-Dunn-Gordon Company of Cincinnati.

The contract for a system of water-works at Dunkirk, Ind., was awarded to the Howe Pump and Engine Co., of Indianapolis, for $17,332.58.

Contracts for the water-works system at Morris, Ill., were awarded to the Snyder-Williams Co., of Dayton, O., the Harvey Boiler Works, Harvey Ill., and C. & T. Iglehart, of Morgan Park. Total cost, $27,801.80. Wittmer & Voorhees, of Buffalo, N. Y., will superintend the work.

The contracts for the extension of the water-works at East Dubuque, Ia., were awarded as follows: Steam pump, boiler and inside connections, Ferguson Bros.; stand-pipe, 100 feet high, Chicago Bridge and Iron Co.; 8,000 feet of new pipe, Dubuque Construction Co.

PUBLIC PARKS.

The Medberry farm has been selected by the committee appointed to examine various sections of the village of Riverside, R. I., for a public park.

W. G. Thompson, Detroit, Mich., has proposed to the council that Brush street and Alexandria avenue be opened through Recreation Park, and he will do the paving himself and donate sixty feet of the center of the city for a park.

STREET RAILWAYS.

An electric railway will be built between Belleville, Ill., and St. Louis, Mo.

A franchise has been granted at Ft. Howard, Wis., for the construction and operation of an electric street railway.

The experiment of using compressed air for street car propulsion has been tried in Massachusetts with satisfactory results.

According to a proposed plan, an electric line will be built between Columbus, O., and Cincinnati, via London, Springfield and Dayton.

A plan is being devised at Lancaster, O., for connecting several other towns from there to the Buckeye Lake Park, by an electric line.

An electric street railway, about twenty miles in length, will be constructed from Lockport, N. Y., to the village of Olcott, on the south shore of Lake Ontario.

The Minch Transit Company has been incorporated at Rockport, O., by Philip J. Minch, J. B. Guthrie, William Gerlach, Robert Wallace and H. D. Coffinbury.

The horse car lines will be transformed into electric lines on the west side, at Chicago. The Van Buren street line will be the first one to be operated by electricity.

The Bucks County Railway Company has been incorporated at Doylestown, Pa., to construct a railway through the principal streets of Doylestown to Centreville and Newton.

When the Ninth street tunnel and bridge is completed at Anderson, Ind., the citizens of Johnstown will ask the electric street railway company of Anderson to extend a line to their town.

The street car lines of Detroit, Mich., which comprises about eighty miles of track, were recently purchased by Thomas Nevins, of Orange, N. J., for $8,250,000. Less than one-half the lines are equipped with the trolley.

It is reported that J. B. Stetson, of Philadelphia, proposes to build an electric railroad from Beresford, on the St. John's river, through DeLand, to connect with the Flayler East Coast system at Lake Helen, Fla.

A franchise has been granted at Anderson, Ind., for an electric railway line through the county, which will be known as the Indiana Gas Belt Company, and will run from Indianapolis to Marion, a distance of seventy-five miles.

A tax is imposed upon street car lines and their receipts at Cincinnati. The present ordinance requires companies to pay into the city treasury five per cent. of their gross receipts and a license of $4 a foot for each year, making about $64 a year on each car.

BRIDGES.

The Wabash bridge at Lafayette, Ind., has been pronounced unsafe.

The contract for a bridge will be let at Loup City, Neb., September 18.

A bridge will be built over the Monongahela river at Bellevernon, Pa.

A new bridge will be built over the St. Joseph river at Buchanan, Mich.

A bridge will be built across the Cimmaron river, near Hennessey, Oklahoma.

A petition has been circulated at Brunswick, Mo., asking for a bridge across Brush creek.

Plans have been adopted for a girder bridge over the river at South street, Warren, O.

A bridge will be constructed across Newark Bay, between Elizabeth and Bayonne, New Jersey.

A bill has been reported authorizing a bridge across the Perdido river, between Florida and Alabama.

An iron bridge has been recommended over Zacharias creek, in Skippack township, Bucks county, Pa.

Bids will be received at Indianapolis, Ind., until September 29, for building a bridge over White river.

Bids will be received until September 10 at Fairbury, Neb., for an iron bridge across the little Blue river.

Bids will be received at Toledo, O., until September 10th, for constructing a bridge over Swan creek at St. Clair street.

The bridge over Salt creek, near Belleville, Kan., has been condemned and will be replaced with a new iron bridge.

Bids are invited until September 10 at Helena, Mont., for constructing two steel or iron bridges across Ten Mile creek.

The commissioners of highways of Moweaqua township, Moweaqua, Ill., contemplate the construction of a steel bridge.

The bill authorizing the construction of a bridge across the Missouri river at Lexington, Mo., has been signed by the President.

The town of Colburn, Mich., has petitioned the county to bear half the expense of re-building the bridge recently destroyed by fire.

The Indiana Bridge Company at Muncie, Ind., was awarded the contract for the Ralston, Brooksburg and Crooked Creek bridges at Madison, Ind.

The F. C. Austin Manufacturing Company of Chicago secured the contract for the iron work on the new bridge over the Dupage at Troy, Ill., for $2,200.

The contract for building a bridge over Grand river, at Michigan avenue, Lansing, Mich., was awarded to the Wrought Iron Bridge Company, of Canton, O., for $62,500.

President Cleveland has signed the bill authorizing the construction of a bridge across the Mississippi river, from Eagle Point, Dubuque, Iowa, to Grant county, Wis.

A petition has been circulated at Freeport, Ill., for a new bridge over the Pecatonica river, to afford an outlet to the residents of Ascherville, and the Triple addition.

The Wrought Iron Bridge Company, of Canton, Ohio, secured the contract for erecting three bridges in Buckeye township, near Freeport, Ill. The contract price for the three bridges is $2,800.

MUNICIPAL BONDS.

Bids are invited until September 3 at Mansfield, O., for the purchase of improvement bonds.

Bids will be received until September 6 at Syracuse, Neb., for the sale of $16,500 of 6 per cent. water bonds.

Sealed bids will be received until September 22 at Tiffin, O., for the purchase of $35,000 of 6 per cent. city bonds.

Bids are invited at Norwood, O., until September 7, for the purchase of $14,361.82 of 6 per cent. improvement bonds.

SEALED PROPOSALS.

STREET PAVING.

Sealed proposals will be received till September 15, 1894, for paving the east, west and middle drives of Woodruff Place, over three miles in length, with asphalt or a concrete foundation of four inches, including combined curb and gutter. Pavement must be guaranteed for five years, and separate proposals are desired for continuing the guarantee five and ten years longer. Right reserved to reject any or all bids. Plans and specifications are on file with the trustees of Woodruff Place. For information address CHAUNCEY BUTLER or Dr. J. R. HUSSEY, Woodruff Place, Indianapolis, Ind.

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INDIANAPOLIS.